OBSERVATIONS

ON THE

GEOLOGY OF SOUTHERN NEW BRUNSWICK,

MADE PRINCIPALLY DURING THE SUMMER OF 1864 BY PROF. L. W. BAILEY, MESSRS. GEO. F. MATTHEW AND C. F. HARTT,

PREPARED AND ARRANGED, WITH

A GEOLOGICAL MAP,

BY L. W. BAILEY, A.M.

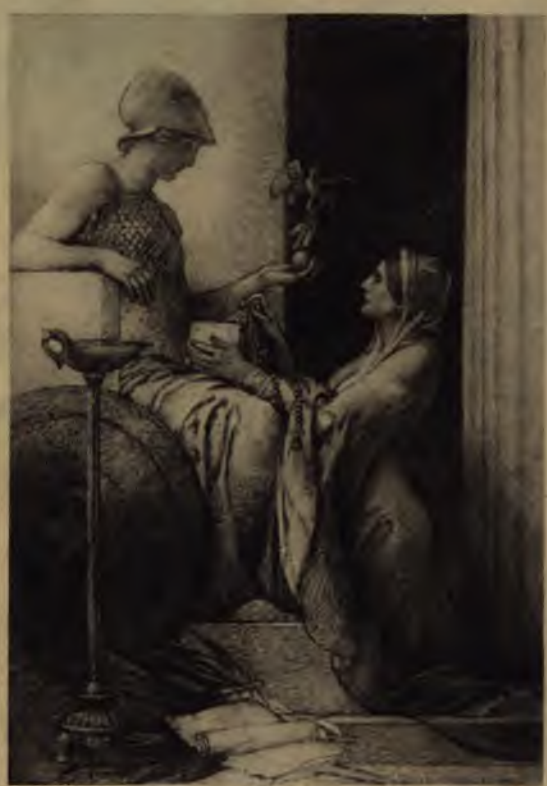
PROFESSOR OF CHEMISTRY, &C. IN THE UNIVERSITY OF NEW BRUNSWICK, PATRON OF THE BOSTON NATURAL HISTORY SOCIETY, AND CORRESPONDING MEMBER OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

PRINTED BY ORDER OF THE HOUSE OF ASSEMBLY.

FREDERICTON.

G. E. FENETY, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY.

1865.



OBSERVATIONS

ON THE

GEOLOGY OF SOUTHERN NEW BRUNSWICK,

MADE PRINCIPALLY DURING THE SUMMER OF 1864 BY PROF. L. W. BAILEY, MESSRS. GEO. F. MATTHEW AND C. F. HARTT,

PREPARED AND ARRANGED, WITH

A GEOLOGICAL MAP,

BY L. W. BAILEY, A.M.

PROFESSOR OF CHEMISTRY, &C. IN THE UNIVERSITY OF NEW BRUNSWICK, PATRON OF THE BOSTON NATURAL HISTORY SOCIETY, AND CORRESPONDING MEMBER OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

PRINTED BY ORDER OF THE HOUSE OF ASSEMBLY.

FREDERICTON.

G. E. FENETY, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY.

1865.

UNIVERSITY OF NEW BRUNSWICK,

Fredericton, February, 1865.

SIR,

I have the honor to transmit herewith, to be laid before His Excellency the Lieutenant Governor and the Legislature, a Report of Observations on the Geology of Southern New Brunswick, made during the Summer of 1864.

I have the honor to be,

Sir,

Your obedient servant,

L. W. BAILEY,

Professor of Chemistry, &c. in the University of New Brunswick.

The Hon. S. L. TILLEY,

Provincial Secretary.

OBSERVATIONS

ON THE GEOLOGY OF SOUTHERN NEW BRUNSWICK.

INTRODUCTION.

The geology of the southern portion of the Province of New Brunswick has long been wrapped in much obscurity, and many different and discordant opinions have been given with reference to the age and distribution of its rock-formations. The highly metamorphic character of its deposits, and the supposed absence of determinable fossils, together with the difficulties to be overcome in tracing the relationships of different groups, where much of the country is still in a wilderness condition, have all contributed in retarding the acquisition of any accurate knowledge of this interesting district.

Within the last few years, however, much further light has been thrown upon the geology of this region. Through the labours of Dr. Dawson of Montreal, Professor Hitchcock of Massachusetts, and other eminent naturalists, but largely also through the agency of a few young geologists of Saint John, much of the obscurity which so long prevailed has been removed. Careful observations have been accumulating, and discoveries of great interest have from time to time been made; and though much yet remains to be done in working out the history and character of this extensive and intricate district, considerable progress has been accomplished, and many of the groups represented may now be co-ordinated with the corresponding groups of other countries.

It has been the object of the Survey, undertaken during the past summer, to collect together the materials thus accumulated, and, taking the facts already known as a basis, to carry on these observations over wider districts. In the pursuit of this object, by far the most interesting and valuable which can at present be undertaken, I have had the cooperation and assistance of those to whom the Province is especially indebted for the labours which first threw a positive light on the age of these obscure groups, Messrs. Geo. F. Matthew, and C. F. Hartt, of Saint John. These gentlemen, during a portion of the summer, have been my travelling companions, and many of the observations hereafter mentioned were made by the one or the other, or by the three conjointly. Mr. Matthew's intimate acquaintance with the varied and puzzling metamorphosed rocks of the lower Counties has been of special service, while the professional studies of Mr. Hartt, together with his experience among the allied formations of Nova Scotia, have well adapted him for the study of the organic forms, which many of these rocks contain.

Before proceeding to give an explanation of the districts which have been examined during the past season, it will be necessary first to briefly review what has already been published on this subject.

The lower portion of New Brunswick, especially including the Counties of Charlotte, King's, Saint John, and Albert, has been long known to be composed of rocks chiefly of a metamorphic character, extending, somewhat irregularly, from the western boundary of the Province eastward as far as Shepody Mountain, in the County of Albert, where they were known to gradually disappear under deposits of carboniferous age. These metamorphic rocks, though extensively altered, were early recognized as being in large part sedimentary, being composed, as usual, of sandstones, conglomerates, shales, and limestones; but these were found to be so intricate in structure, and so much confused by the occurrence of beds of volcanic origin, that little if any attempt was made to separate them into groups, or to determine their relative age and distribution.

By Dr. Gesner, who first undertook a systematic survey of the Province, but at a time when the ideas entertained of geological phenomena were much more vague than at present, the general character of the district to be described was recognized, and a division made into several groups. To the westward of the Saint John River, and in the County of Charlotte, the existence of a broad belt of granitic rocks, extending from the neighbourhood of Saint Stephen to the Saint John River, was pointed out, as was also the occurrence of another district southward of the above, and consisting principally of syenite and trap. The latter band of rocks was stated to be continuous across the Peninsula of Kingston, and to constitute the broken tract of country eastward of the Saint John, in the neighbourhood of Loch Lomond, and thence to Shepody Mountain.

South of the above, and stretching across the entrance of the Saint John, another group of rocks, classed as Silurian, and consisting of syenite, slate, and trap, with large beds of altered limestone, was pointed out, and stated to extend eastwardly into the County of Albert. The syenite was described as forming an anticlinal, against the slopes of which reposed the rocks of sedimentary origin. The limestones of the group, though well developed at the outlet of the Saint John, were found to be comparatively local, not extending to the eastward beyond the Hammond River. To the west, however, limestones, referred to the same group, were found at several points in the County of Charlotte.

The slates and "greywacke" of this system, on the eastern side of the Saint John, which were described as containing the remains of plants and mollusks, were stated to be of wider distribution, running parallel to, and leaning upon the "primary" rocks through their whole extent.

Yet another group of altered rocks, consisting of micaceous, chloritic and talcose slates, with sandstones, conglomerates and trap beds, and largely developed in the neighbourhood of Mispeck and Black River, was pointed out, and from the evidence of apparent unconformability and the absence of

fossils, was pronounced to be of earlier origin than the group already referred to as Silurian, and, like the syenite in the interior, was denominated "primary." It will hereafter be seen that these rocks are really newer than any of the groups above described.

Upon the western side of the Saint John, the relations of the several groups were less clearly distinguished, and the geology of that portion of the Province has always been in great confusion. The great alteration of the deposits represented, the abundance and variety of volcanic beds, and the disconnected nature of the observations made, have all contributed to this result. Besides the band of granite above alluded to, however, the existence of a wide spread series of micaceous slates, frequently associated with trappean beds, was recognized, and was found to occupy a considerable area in the western portion of the Province, extending along both flanks of the anticlinal* granitic axis, and thence bending northward and eastward to meet another and yet more extensive granitic range, occupying a wide belt of country, and stretching from the Cheputneticook Lakes completely across the Province. These rocks were classed as the Cambrian system.

In the triangular space thus left, extending over an immense area, and widening from its western limit, the Oromocto Lakes, was placed the great coal field of the Province, separated however from the Cambrian system by a bed of sandstones, of variable thickness and occasional beds of limestone. The age of the limestone was rightly referred to the base of the Carboniferous system.

The sandstones, surrounding the coal measures, and along its northern and southwestern sides consisting of but a narrow belt, were found to widen greatly to the southeast, occupying an extended area in King's and Westmorland, stretching indeed from the Kennebeccasis and the Belleisle, eastward beyond Moncton. Southward of the latter place and along a space of considerable width, extending through the central portion of Albert into the Parish of Sussex, other sandstones were pointed out and referred to the true Coal Measures. Below the latter, however, red sandstones, similar to those of the Sussex Valley, were again found between Salisbury Cove and Hillsborough, as also at Dorchester and Sackville. These reddish sandstones, which were found to be characterized throughout by the presence of salt and gypsum, were at first referred by Dr. Gesner to the New Red Sandstone or Saliferous System of Europe, but subsequently, from their resemblance to similar beds in Nova Scotia, to the Carboniferous System.

Besides the sandstones above alluded to, others of variable character, and in isolated deposits, were found at several points along the northern shore of the Bay of Fundy, especially at Saint Andrews, Saint George, Lepreau, and Quaco. These were variously referred to the Carboniferous and New Red Sandstone Groups.

*Note.—In the use of geological terms throughout this Report, it has been taken for granted that readers either have, or possess the means of obtaining, a general knowledge of their meaning or application. Any other course would greatly increase the difficulty of explanation, and at the same time enlarge the Report to undue limits.

Combining the observations thus collected by Dr. Gesner, and at the same time adding to and correcting the same by his own labours, the late Dr. Robb, at the request of Professor Johnston, constructed a geological map, to accompany the latter gentleman's Agricultural Report, and to show at a glance what was then known of the structure of the Province.

This map has heretofore been the only one extant, and has been regarded by those out of the Province as the best authority upon the geology of this country. Its principal faults are these:—

1st. The various formations indicated by special colours are, with a few exceptions, made to represent mineralogical characters only, and not distinct geological groups. One colour represents red sandstones of whatever age.

2nd. Not sufficient distinction has been made between the different varieties of eruptive rocks. Two colours are employed, one indicating granite, gneiss, &c., the other trap, syenite, felspar rock, &c. This has given rise to the occurrence over all portions of the map of isolated patches of igneous rocks, leaving it impossible to connect them into any consistent series, and equally impossible to determine which of these several varieties of rock is meant to be indicated. The presence of stratified beds among these eruptive rocks seems to have been entirely overlooked.

3rd. The map is constructed upon too small a scale to allow of that accuracy of detail so desirable in a map of this description.

I do not by these criticisms desire in any way to disparage the labours of Dr. Robb. His work was faithfully and zealously performed, and to no one were the imperfections of the map more thoroughly known than to himself. At that period no better map could have been readily constructed, and the method adopted of representing mineralogical rather than geological formations, answered the purpose for which it was employed, while it left all doubtful points to be determined by subsequent exploration. While presenting this map, however, Dr. Robb made two very important observations; first, that most of the red coloured sandstones, with and without gypsum, were of an age below the productive coal measures, being either of the age of the mountain limestone, or perhaps Devonian, instead of New Red Sandstone, as supposed by Dr. Gesner; secondly, that the district described by Dr. Gesner as trappean in the Counties of Saint John, Charlotte, King's and Queen's, is a slate country, although much disturbed by igneous action. It will be hereafter seen that both of these observations of Dr. Robb have been confirmed.

The want of a purely geological map, which should distinguish with accuracy the position and distribution of these different groups, has continued to be felt. Principal Dawson, in a map accompanying his Acadian Geology, corrected some of the errors of the earlier map, and suggested the probable Devonian age of many of the altered sediments of the Southern Counties. This map, however, as far as related to New Brunswick, was still imperfect, and much remained to be done in working out the doubtful groups. In the meantime, deposits, somewhat similar to those occurring in New Bruns-

wick, were pointed out in Nova Scotia, Canada and Maine, and from the study of their fossils were pronounced to be of Devonian age.

Among those especially active in endeavouring to throw light upon the structure of this section, was an association of young geologists in the City of Saint John, who, under the guidance of Messrs. Hartt and Matthew, explored the different formations in the neighbourhood of the City, and succeeded in discovering facts which have made the geology of this district second in interest to no portion of North America. Rocks before supposed to contain no determinable fossils, were ascertained to be rich in organic relics, and a band of slates, stretching across the Harbour of Saint John, was discovered, rich in an abundant and beautiful fossil vegetation. By the study of these remains, Principal Dawson was enabled to ascertain the true age of the deposits in which they occur, pronouncing them to be the equivalents of the Chemung and Portage Groups, sub-divisions of the Upper Devonian rocks of the State of New York.

The same author, in June, 1861, after an examination of certain fossils from Perry in Eastern Maine, asserted the Devonian age of the rocks containing them, and also of the sandstones constituting the peninsula of Saint Andrews, which they closely resemble.

Examinations were also made by the same geologist of the formations in the vicinity of the Saint John, both alone and in company with Mr. Matthew. The latter gentleman, in the mean time, had given much attention to the mineralogical character and stratigraphy, as well as to the fossils of these groups, and many of his observations, combined with those of Dr. Dawson, were published in the Canadian Naturalist, and in the Journal of the Geological Society. At the same time Mr. Hartt had collected in large numbers the interesting fossils in which many of the beds abound.

The result of the labours of these gentlemen was the recognition in the neighbourhood, and to eastward of Saint John, of an extensive series of sedimentary and volcanic beds, capable of being subdivided into groups, and to a certain extent, of being coordinated with better known deposits elsewhere. These groups, to which numbers were attached, were originally published by Dr. Dawson, in an article on the Devonian Flora of Northeastern America, in the November number, (1862), of the Journal of the Geological Society.

Subsequently, Mr. Matthew, who had extended his observations over a wider area, including most of the country to the eastward of Saint John, within an area of ten miles radius, and in the direction of Quaco, published in the Canadian Naturalist a more detailed account of this district, and assigned a number of local names to the different groups described. These names, adopted temporarily until the precise age of the different deposits could be ascertained, will be employed throughout the present Report.

It will be impossible to repeat here the numerous facts, and the interesting observations made by Mr. Matthew. Many of them will be incidentally alluded to in describing the result of the present season's work. The others may be readily ascertained by reference to that gentleman's published article on the vicinity of Saint John.

The Groups alluded to, taken from Mr. Matthew's paper, are as follow:—

PORTLAND GROUP.—(Nos. 7 and 8 of Dawson,) Thickness unknown. Granite and syenite, mica schist and gneiss, limestones, clay slates, and sandstones. *Fossils.*—Fragments of plants in the upper beds.

COLDBROOK GROUP.—(No. 6 of Dawson in part.) Thickness 3,000 feet or more.

a. Greenish grey slate, stratification very obscure.

b. Bright red slaty conglomerate, and dark red sandy shale.

c. Reddish conglomerate and grit, hard grey sandstone.

SAINT JOHN GROUP.—(Nos. 5 and 6 in part of Dawson.) Thickness 3,000 feet or more. Several zones of soft black and dark grey finely laminated shales, alternating with zones of coarser grey slates, containing numerous thin beds of fine grained sandstone. *Fossils*—Lingula, a conchifer, annelides, coprolites.

BLOOMSBURY GROUP.—(No. 4 of Dawson.) Thickness 2,500 feet.

a. Basalt, amygdaloid, trap ash, trap ash slate; some beds of conglomerate. Thickness, 2,000 feet.

b. Fine grained red clay slate, Reddish grey conglomerate, } Thickness 500 feet.

LITTLE RIVER GROUP.—(Nos. 2 and 3 of Dawson.) Thickness 5,200 feet.

a. "Dadoxylon sandstone"; grey sandstone and grit, with beds of dark grey shale, sometimes graphitic. Thickness 2,800 feet. *Fossils.*—Numerous plants, several crustaceans, wings of insects. (C. F. Hartt.)

b. "Cordaite Shales"; grey, greenish, and red shales; reddish and grey sandstones, grits and conglomerates, alternating with the shales. Thickness, 2,400 feet. *Fossils.*—Cordaites, calamites, stigmaria, ferns, &c. for the most part identical with those of the preceding section.

? Granulite or granitic sandstone, micaceous slate, trap ash.

MISPECK GROUP.—(No. 1 of Dawson.) Thickness 1,800 feet.

a. Coarse subangular conglomerate.

b. Fine-grained purple clay slate and grits, surmounted by slate conglomerate.

? Red and green slate, basalt, (stratified?).

As I have before stated, the observations upon which the above Table is based were confined for the most part to an area contained within a semi-circle, described with a radius of about ten miles, around and to the eastward of the City of Saint John, extending however along the coast in the direction of Quaco. The details above given are intended to refer only to that limited area, the fossils enumerated and the thicknesses given being all derived from observations there made.

So much having been ascertained of the geology of this section, it has been the object of the present survey to carry on the work so well begun, to trace to the eastward the several formations above described, and to note down for the construction of a more accurate Geological Map, the position and limits of the different groups.

While, however, the geology of the lower Counties has been the primary object of this survey, attention has been paid to the mineral contents of the several beds, and the presence or absence of valuable ores as far as possible ascertained. In addition, also, an attempt has been made to study the topography of the district under examination, and to ascertain the agricultural capabilities of the soils which it includes.

The observations of the past season have been for the most part confined to the three Counties of Saint John, King's, and Albert, which have been studied with great care. Cursory examinations, however, have been made of districts beyond these limits, and where they have had direct connection with the objects of the survey, they have been attentively pursued, and will be treated of in their appropriate places.

EXPLANATION OF THE GEOLOGICAL MAP, AND TABULAR LIST OF FORMATIONS.

The Geological Map which accompanies this Report, is intended to illustrate the structure of the lower portion of New Brunswick, so far as can be done from the data now known. It was originally designed to include the Geology of three Counties only, viz:—Albert, Saint John, and King's; but a considerable amount of information having accumulated, bearing upon the character of the adjacent Counties, it has been deemed advisable to extend its limits, including all that portion of the Province south of an east and west line from Fredericton to the Bend of the Petitcodiac. It has thus been made to include a portion of the great coal field of the Province, as well as of the County of Charlotte. It is not designed, however, that it should completely represent the geology of the latter districts, where much labour must yet be expended in ascertaining points still wrapped in great obscurity, but only to indicate their probable structure, and connection with the districts better known.

It will be seen by an examination of the Map, that as many as fifteen different groups of rocks are represented, each occupying a greater or less extent of country, and indicated by a particular colour. These different groups include rocks of all ages, from the oldest, to those which are still under process of formation by causes now in action.

A brief review of the nature and position of these several groups will serve to render the subject more intelligible. As far as possible the colours chosen are intended to represent the prevailing colour of the formations which they indicate.

Occupying a considerable area in the Parish of Portland, crossing the main river in the neighbourhood of Indiantown and the Falls, and extending thence in ridges of moderate elevation to the eastward, is a series of rocks, generally regarded as the oldest represented in that vicinity. They consist principally of rocks extensively altered, such as granite, gneiss, mica schist,

In the determination and study of the data from which the present Map has been constructed, use has been constantly made of the very excellent Topographical Maps published by W. E. and A. A. Baker, of the four Counties of Albert, King's, Saint John, and Westmorland. The large scale upon which these have been compiled, together with their accuracy and minuteness of detail, have rendered them of great service, enabling us to determine and to mark with precision the limits of the several groups, and the position of valuable deposits.

The Map now under consideration has been reduced from the above to a size deemed more convenient. It has been constructed from an outline Map, (unpublished,) now in the Crown Land Office, made somewhat fuller in detail, as the case demanded. We trust, that so far as our labours have extended, its representations will be found accurate.

&c., with some thick beds of crystalline limestones. These latter contain occasional bands of shale, and several beds of impure graphite. They may be seen on both sides of the river above Indiantown, also at Lily Lake and many other localities. They extend to the eastward a little beyond the Hammond River, where they disappear below beds of carboniferous age. To the westward of the Saint John they may be distinctly traced, and they occupy a considerable area in the County of Charlotte.

The group is represented upon the Map by a colouring of pale blue, the beds of limestone which it contains being indicated by brighter bands of the same tint. From its development in the Parish of Portland it has been named by Mr. Matthew the Portland Group, and will be shown to be the representative of the Azoic rocks of other countries, wholly or in part.

Resting upon the beds of the Portland series, and widening out rapidly to the eastward, is a thick deposit of greenish-grey altered slate, of a volcanic character, surmounted by conglomerates of grey, red, and purple colours. Though forming but a narrow strip in the neighbourhood of Saint John, these rocks occupy an extensive area to the eastward, rising in bold hills, as far as, and beyond, the Loch Lomond Lakes. They have been termed the Coldbrook Group, being well exposed in the valley of that name.

They are indicated upon the Map by pale green and red colours, (representing respectively the lower and upper beds,) and belong probably to some portion of the Azoic system.

The above group of rocks is succeeded by the extensive series of dark coloured slates and shales, which underlies a considerable portion of the City of Saint John. It extends for some distance to the eastward, but has not been recognized to the westward beyond Carleton. The fossils, which occur abundantly in some localities hereafter mentioned, have shown this group, which has been termed the Saint John Group, to be the equivalent of the Potsdam or Primordial Group of the New York geologists.

The next series in the geological succession is composed of rocks principally of a volcanic character, such as basalt, amygdaloid, and trap-ash. Like the Coldbrook Group, however, which they greatly resemble, these volcanic rocks are associated with and overlaid by reddish conglomerates and slates, destitute of fossils. The volcanic beds of the group are extensively developed, and may be traced far to the eastward, (of a dark green colour,) surrounded and surmounted by their sedimentary beds, which are tinted of a deep red colour. The relations of these beds to those above and below them, seem clearly to indicate that they form a portion of the Upper Devonian series.

They have been termed as a whole, the Bloomsbury Group, deriving their name from the Bloomsbury Mountain, in the Parish of Simonds, where they are well exposed.

It is important to remember, that both the Coldbrook and Bloomsbury Groups are essentially volcanic, being in reality great lava streams, though associated with deposits of aqueous origin.

Next above the aqueous deposits forming the upper member of the Bloomsbury Group, is a series of rocks by far the most interesting of those represented in this section of the Province, both for the information which by their fossils they have thrown upon the age of the associated beds, and for the many valuable mineral deposits which they have been found to contain. The group has been termed by Mr. Matthew, the Little River Group, and has been subdivided into several members, which have already been enumerated in the introductory chapter. The lower member is composed principally of sandstone, holding a fossil plant called *Dadoxylon*, and is represented by a shading of pale grey; the upper, abounding in fossil ferns, but especially in a plant called the Cordaite, is of a shaly character, and has been called the "Cordaite Shale." With these is associated in the neighbourhood of Black River, on the Bay Shore, as well as to the westward of the Saint John, in the peninsula of Pisarinco, a thick series of highly altered semi-granitic rocks, holding at the former locality valuable deposits of iron and copper ores.

The Little River Group is extensively developed, especially in its upper members, and with the next to be described, occupies a large area throughout the Counties bordering on the Bay. The study of its fossils has enabled Principal Dawson to refer the group to the Chemung and Portage Epochs of the New York geologists, subdivisions of the Upper Devonian of that State. It is in beds of this series that the rich copper-bearing deposits of the Bay Shore, at Martin's Head and elsewhere, occur. Their position on the Map may be readily traced by the colour, a pale purple.

The next group in the geological scale is what has been termed by Mr. Matthew the Mispeck Group, from the River and district of that name. It is indicated upon the map by a colouring of *bright* purple.

In addition to the deposits above described, two others may be here alluded to, separated geographically from the others, but associated in their geological relations. These are the rocks of Kingston, (probably Upper Silurian,) coloured of a yellow tint, and the mica schist or Cambrian formation of Queen's County. The latter is indicated by a colouring of ochre.

The rocks so far described, from the base of the Portland Series to the upper beds of the Mispeck Group, are for the most part *altered* rocks, *i. e.* rocks so changed from their original character and appearance by volcanic and other agencies, as to leave much doubt with reference to the conditions of their first formation. Such rocks are commonly termed metamorphic rocks, and the series so far described, and which occupies by far the greater portion of the lower Counties, has been termed by Dr. Dawson the "coast metamorphic series of New Brunswick."

Scattered among these metamorphic rocks, and occupying areas of very variable extent, are rocks of a totally different character. They include granite, syenite, porphyry, trap, &c., when the rocks so named are clearly of an eruptive, and not a sedimentary or metamorphic origin. These eruptive or igneous rocks, which may occur associated with formations of

any age, are upon the Map designated by a bright *crimson* colour. In accordance with their mode of formation, they have frequently thrust through and violently disturbed the beds of more peaceful origin.

The metamorphic and eruptive rocks now described, occupy the principal portion of the Counties of Charlotte, Saint John, King's, and Albert. In the two latter, however, there are also extensive deposits of a later age.

The valley of the Kennebeckasis, and its extension into Sussex Vale, the valley of the Belleisle, and its extension eastward towards Bull Moose Hill, together with an immense district along the valley of the Petitcodiac, is composed of red and grey sandstones, conglomerates and shales, producing a soil usually of a brownish red tint, and characterized by the presence at many points of limestone, salt, and gypsum.

These gypsiferous sandstones, which form some of the richest tracts of land in the Province, were at first referred by Dr. Gesner to the New Red Sandstone System, but subsequently to the Lower Carboniferous. The latter is now universally recognized as their true age. They are indicated on the map by a coloring of vermillion, and include the famous coal-bearing shales of the Albert Mines. Like the Portland, these sub-carboniferous beds hold large deposits of limestone. Unlike the latter, however, these limestones are not metamorphic, and are highly fossiliferous. They are distinguished by cross bands of a bright blue colour. Deposits of gypsum of the same age are similarly indicated by bars of crimson.

Resting upon the sub-carboniferous beds, occupying detached areas along the coast, and an extensive district in the centre of the Province, are the coarse grey sandstones, shales and grits of the Coal Measures. These are indicated by a simple brown colour, outcrops of coal being designated by spots of black.

At several points along the shore of the Bay of Fundy to the eastward of Saint John, will be observed small patches of a bright orange colour, as at Quaco and elsewhere. These indicate the only representatives in New Brunswick of a group occupying large areas in Nova Scotia and probably the whole of Prince Edward's Island, the New Red Sandstone.

These are the newest rocks represented in the Province, with the exception of the gravels, clays, &c., of the Drift Period, which, as they would necessarily cover and conceal all older groups, are not usually represented on geological maps. The alluvial deposits, however, such as marshes and river intervales, which occupy extended areas, and which are still in process of formation, are indicated by a dark brown colour.

To present the foregoing facts in a more convenient form for reference, and at the same time to show the parallelism, so far as it can be traced, between the deposits of New Brunswick and those of other countries, the following Table, suggested by a somewhat similar one in the Acadian Geology of Professor Dawson, has been constructed. Its object is to compare the

age of the different groups above detailed with similar ones in England, Canada, Nova Scotia, and the United States.

The names in the first column, representing the different geological periods, are adopted from the most recent authority, Dana's Manual. Those of the second column, indicating the deposits of England, Canada, &c., are taken from a variety of sources, among others, Dawson's Acadian Geology, and Dana's Manual.

The third column has been constructed by myself, partly from my own observations, and partly from those of Dr. Dawson, Mr. Matthew, Dr. Gesner, and others.

The Table will be found a convenient one for reference.

Tabular View of Rock Formations in New Brunswick, compared with those of England, the United States, Canada, and Nova Scotia.

Ages and Periods.	Names and Localities in England, United States, Nova Scotia, and Canada.	Names and Localities in New Brunswick.
	I. MODERN.	
Modern,	Peat Mosses, Shell Marls, River alluvia, Infusorial earths, Estuary Deposits and Deltas,	Peat Bogs, Diatomaceous earths, &c. River Intervales, Marshes, Shell Marls, Lawlor's Lake, &c.
	II. CENOZOIC. A. Post-Tertiary.	
Terrace period,	River, Lake and Beach Terraces,	Terraces of St. John River and its tributaries, Raised beaches,
Champlain Period,	Superficial Gravels,	Fossiliferous clays, Saint John, St. Andrews, &c. Gravels, frequently stratified.
Glacial or Drift,	Boulder formation, Cavern deposits, England, Boulder formation, or Drift, United States,	Boulders, in trains or scattered. Boulder clays.
	B. Tertiary.	
Pliocene,	Lower Crag, England, Tertiary clay and sand, N. Carolina, &c.	Not found in New Brunswick.
Miocene,	Tertiary clays and sands of N. Carolina, Maryland, N. York, Massachusetts, &c.	" " "
Eocene,	Tertiary sands and marls of England, " " Maryland, Virginia, &c.	" " "
	III. MESOZOIC.	
Cretaceous,	Chalk, Greensand, &c. England, Greensand of New Jersey, Limestone of Missouri,	Not found in N. Brunswick.
Jurassic,	Wealden, Oolite and Lias of England, Lias sandstone, shale, and coal, Richmond, Va.	" " "
Triassic,	Upper New Red Sandstone, England, New Red Sandstone, Connecticut, Nova Scotia, and Pr. Ed. Island,	New Red Sandstone of Gardner's Creek, Quaco, and Salisbury Cove.

Tabular View of Rock Formations in New Brunswick, &c.—Continued.

Ages and Periods.	Names and Localities in England, United States, Nova Scotia, and Canada.	Names and Localities in New Brunswick.
	IV. Palaeozoic. A. Carboniferous.	
*Permian,	Magnesian Limestone, Lower New Red, England, Limestones, sandstones, marls, &c. Kansas,	Not found in New Brunswick.
Carboniferous,	Coal measures, England, Millstone grit. " " Pennsylvania, Illinois, Nova Scotia,	Coal measures of Gd. Lake, and the Counties of York, Sunbury, Queen's, &c.
Sub-Carboniferous,	Mountain limestone, England, Sub-carboniferous limestone, sandstone, clay iron ore, &c.. United States, Limestones, gypsiferous sandstones and marls, Nova Scotia,	Sub-carboniferous limestones of Hampstead, Rush Hill, Bull Moose Hill, &c. Gypseous and saliferous sandstones of Sussex, Tobique, and Hillsborough. Fish-bearing shales of the Albert Mines.
	B. Devonian.—(Old Red Sandstone of England.)	
Upper Devonian,	Chemung & Portage Groups, N.York, Upper Sandstones? Gaspe, Canada, Hamilton Group, New York,	Mispeck, Little River and Bloomsbury Groups.
Lower Devonian,	Upper Helderberg, New York, Upper Limestone, Canada, Oriskany Sandstone, New York,	Unrepresented as far as known. Possibly some portion of the Kingston Group.
	C. Silurian.	
Upper Silurian,	Lower Helderberg Limestone, Salina Group, N.York Ludlow Beds, England, Gaspe, Canada, Niagara Group, New York, Wenlock Beds, England, Gaspe,	Upper Silurian fossiliferous limestones of Dalhousie, Restigouche County. The rocks of Kingston, if not Middle Silurian.
Lower Silurian,	Hudson River Group, New York, Caradoc Sandstone, England, Trenton Limestone, New York, Bala Limestone and Llandeilo Flags, England, Potsdam or Primordial, New York, Quebec Group, Canada,	Not represented as far as known. " " " Saint John Group.
	V. Azoic.	
Azoic,	Huronian Series of Canada, Laurentian Series, Canada, Azoic Rocks, New York,	Coldbrook Group probably. Portland Group, if not Huronian.

Each of the above named groups, so far as it is represented in the districts which have been examined, will now be more minutely described.

*In assigning a Triassic rather than a Permian age to the Red Sandstones of the Bay of Fundy, I have followed the authority of Professor Dana, who denies the existence of the latter, east of the Mississippi River. It is proper to state, however, that by some individuals a contrary view is entertained.

It will be found most convenient to begin at the end rather than at the beginning of the scale above given, as we shall thus adopt the true order of succession in the rocks themselves, and obtain a more just and comprehensive view of their historical sequence.

AZOIC ROCKS OF SOUTHERN NEW BRUNSWICK.

As implied by the name they bear, the Azoic Rocks have until recently been supposed to be entirely destitute of all traces of organic life, and according to the views usually entertained by Geologists, were formed at a period antecedent to the introduction of organic beings. Although this idea has been found to be erroneous, by the discovery of animal fossils in the so-called Azoic or Laurentian rocks of Canada, yet the latter are so minute and of such a low order of organization, that we may well regard the beds containing them as essentially Azoic, or at least as indicating that period when, after ages totally destitute of life, the humblest forms of vitalized beings were introduced upon the globe. Hence arises the great difficulty of distinguishing the true Azoic rocks from those of subsequent date, for many of the latter, though once supporting an abundant life, are now equally destitute of fossils.

The series which has heretofore been referred to the Azoic age in New Brunswick, consists of the several broad bands of granitic rocks already alluded to, which extend obliquely across or partly across the Province from the State of Maine, and which were termed by Dr. Gesner and others, "the primary series."

For reasons hereafter stated, it is rendered certain that the rocks in question cannot possess the high antiquity which has been thus assigned to them. Their relations to the associated beds, their lithological character, and their resemblance to similar beds in Nova Scotia, all alike indicate that the period of their formation and upheaval was of a much less ancient date, probably as late as the Devonian, certainly not earlier than the Upper Silurian. The facts bearing upon this question will be detailed hereafter.

While therefore it is thus improbable that the granites above referred to can belong to the Azoic age, there is another group of altered sediments largely developed along the southern coast, to which the assignment of such an origin is much more rational. I refer to the extensive series of metamorphic beds, comprising granite, syenite, gneiss, and limestone, which occur in the vicinity of Saint John, and which has already been referred to under the name of the Portland Group. As this series is undoubtedly the most ancient in this portion of the Province, and forms the foundation on which repose the succeeding Silurian and Devonian beds, it will be first described, the several overlying groups being subsequently considered in the order of their natural succession.

PORTLAND GROUP.

CHARACTERS.—The following description of the Portland Group is taken from a paper by Dr. Dawson on the Flora of the Devonian Period. It is meant to apply only to the district immediately about Saint John, and could not be more concisely or accurately given :—

"The oldest rocks seen in the vicinity of Saint John are the so-called syenites and altered slates in the ridges between the City and the Kennebeckasis River. These rocks are in great part gneissose, and are no doubt altered sediments. They are usually of greenish colours; and in places they contain bands of dark slate and reddish felsite, as well as of grey quartzite. In their upper part they alternate with white and graphitic crystalline limestone, which overlies them in thick beds at M'Clakeney's and Drury's Coves on the Kennebeckasis, and again on the Saint John side of an anticlinal formed by the syenitic or gneissose rocks, at the suburb of Portland. These limestones are also well seen in a railway-cutting five miles to the eastward of Saint John, and at Lily Lake. Near the Kennebeckasis they are unconformably overlain by the Lower Carboniferous conglomerate, which is coarse and of a red colour, and contains numerous fragments of the limestone.

"At Portland the crystalline limestone appears in a very thick bed, and constitutes the ridge on which stands Fort Howe. Its colours are white and grey, with dark graphitic laminæ; and it contains occasional bands of olive-coloured shale. It dips at a very high angle to the southeast. Three beds of impure graphite appear in its upper portion. The highest is about a foot in thickness, and rests on a sort of underclay. The middle bed is thinner and less perfectly exposed. The lower bed, in which a shaft has been sunk, seems to be three or four feet in thickness. It is very earthy and pyritous. The great bed of limestone is seen to rest on flinty slate, and syenitic gneiss, beneath which, however, there appears a minor bed of limestone."

To this brief and very accurate description, Mr. Matthew now adds :—

"The limestones, altered (pyritous) slates, and graphite beds described by Dr. Dawson, constitute the upper portion of the group. Beneath it is a thick series of grey altered sandstones and gneiss, with gneiss-conglomerate, reposing upon grey and white limestones (equal in thickness to the first mentioned calcareous beds), which in turn rest upon a ridge of syenite, separating it from the great mass of thick-bedded limestones running from the Narrows of the Saint John River, through the middle of the Parish of Portland, to Hammond River and beyond. In this central band and that which skirts the Kennebeckasis, most of the lime quarries have been opened. Beyond it and the associated syenite, the sequence of the strata cannot easily be made out, owing to faults and overturn dips, there seeming to be a repetition of the strata in several ridges of limestone, syenitic grit, arenaceous shales, sandstones and syenite, along the shores of Kennebeckasis Bay, (where the strata are less altered), and in the Islands which dot its surface.

The thickness, in that part of the group in which the succession can be made out, is probably not less than 4,000 feet."

DISTRIBUTION.—The Portland Group, largely developed in the Parish from which its name has been derived, occupies an area of nearly uniform breadth, extending from the Narrows of the Saint John River, northeastward along the southern shore of Kennebeckasis Bay. Near the main river its breadth is somewhat contracted, being overlaid between the opening of the Narrows and Sandy Point on the Kennebeckasis, by a detached area of Lower Carboniferous conglomerates. The last named bed of rocks is, however, of little thickness, and the older group re-appears again in the Islands known as "The Brothers." From Sandy Point to the eastward the group is easily traced, being well exposed in the cuttings along the line of the railway. It has been observed as far as, and beyond, the Hammond River. There, however, a portion abruptly terminates, where this stream turns suddenly to the northward, in bold cliffs, which, as suggested by Mr. Matthew, may possibly mark the line of a fault in these older beds.

The upper limit of the Portland Group is a line extending along the north shore of the Kennebeckasis (where many of the Islands are partly composed of this series) to a point a little beyond Rothsay, thence eastward nearly along the line of the Railway to the Hammond River. The southern limit would be indicated by a similar line extending from the Suspension Bridge, through Indiantown, back of the City, a little north of the Marsh Creek; thence eastward in a nearly straight northeasterly course to the Golden Grove settlement, beyond which rocks of a later age appear.

Westward of the Saint John River the same group occurs and fills the space between South Bay and the Suspension Bridge. Thence it extends far to the westward and occupies an immense area, but the observations in this almost uninhabited district have been of too disconnected a character to enable us to mark its limits with precision. It has, however, been observed at the following points:—

Along the road to Musquash and St. Andrews, rocks of this group appear as far as the foot of Spruce Lake. Thence they may be traced southerly on the road to Pisarinco, as far as the Mill Creek, near the mouth of the Manawagonish Cove, of which they form the north side, the group being here represented by a long ridge of limestone, extending to the westward. South of the Mill Creek, Silurian (?) and Devonian rocks appear.

From the foot of Spruce Lake to Musquash, the rocks are chiefly syenites of the Portland series, one detached area, however, of coarse reddish conglomerate, undoubtedly Devonian, occurring along the south side of the Lake.

At the village of Ivanhoe, on the Musquash River, the syenites of the Portland series are again partially covered with Devonian rocks, near the mills of Messrs. Knight & Co. To the north of the latter, however, they are distinctly visible, and have been traced along the line of the river, to a point within a few miles of the southern shore of Loch Alva. They consist, in part, of granite and syenite, but also contain, as observed by Mr. Matthew, gneissoid beds, and not unfrequently become granulite by the absence of mica and hornebleude. They also hold at Donelly's mill a few thin beds of altered slate.

Westward of Ivanhoe, and between the latter place and the village of Lepreau, the rocks are partly of the Portland series and partly volcanic beds of Devonian age. The

former are first met along the St. Andrews road, about five miles west of Knight's mills, and occupy a wide area; the latter are seen at Hanson's Creek, and thence extend as far as Lepreau village. The development of the Portland rocks in Charlotte County will be alluded to hereafter.

AGE.—It might readily be supposed that the extreme metamorphism exhibited by the rocks of the Portland Group would be accepted as conclusive evidence of their great antiquity. Indeed the fact of such antiquity could scarcely have been doubted, were it not for the intimate association and almost entire conformability between the beds of this and the overlying groups, which have heretofore induced all the observers who have examined the district to link them in a single series. As the latter are unquestionably of Upper Devonian age, the beds of Portland were supposed to represent either a portion of the Lower division of the same formation, or possibly the upper part of the Silurian. Dr. Dawson alone, while still adopting the latter view, called attention to the great resemblance between these rocks and those of the great Laurentian Series of Canada. It is with much gratification that we are now enabled to confirm, with a good degree of certainty, this opinion of their antiquity and geological position.

The facts upon which this decision is based are chiefly these: first, the great metamorphism of the series, and secondly, the position which it holds with reference to the overlying formations. It will be impossible clearly to explain the latter without anticipating the description of the groups which are to follow, but it will be sufficient here to say that one of these groups, that of Saint John, formerly supposed to be connected with the Devonian Series, has been shown upon the evidence of its fossils to be undoubtedly Primordial, or to be the equivalent of the Potsdam rocks of other portions of North America—rocks at the very base of the Lower Silurian Series. Were the rocks of Portland simply underneath the fossil-bearing beds of the Saint John Group, we should still be obliged to regard them as Azoic; but, as will hereafter be shown, they are really separated from the latter by the entire mass of the Coldbrook Group, representing certainly not less than 7000 feet of stratified deposits, which must have been formed in the interval between the laying down of the Portland beds, and the shales and sandstones of Saint John.

If then, as is probable, the Coldbrook Group is the partial representative of the Huronian beds of Canada, we cannot hesitate in assigning the subjacent syenites and limestones of Portland to the great and still more ancient Laurentian Series, a group heretofore supposed to be unrepresented in this portion of the Continent.

In corroboration of this view, we have only to call attention to the great similarity of the two formations in their mineral composition and their extreme metamorphism. Without entering into minute details, (for the study of which the reader is referred to the Reports of Sir William Logan on the Geology of Canada,) it may be sufficient here to say that this resemblance is apparent in the succession of stratified deposits, consisting in both, principally

of gneiss, quartzite, limestone, anorthosite? and occasional bands of mica schist, together with syenite, and rocks which can with difficulty be distinguished from intrusive granites. Both hold beds of graphite, sulphurets of the different metals, serpentine (in connection with the calcareous beds, producing ophiolites), as well as many simple minerals, such as horneblende, muscovite, pyrallolite? tourmaline, felspar, and others. The abundance of magnesian silicates in the Portland rocks is also remarkable, as observed by Mr. Matthew, and suggests the possibility that the limestone may in part be dolomitic like the similar calcareous beds of the Laurentian.

Topographical Features.—Though constituting the foundation and anticlinal axis, on the slopes of which the newer groups repose, the Portland rocks have nowhere more than a very moderate elevation. They are, however, usually of a rough and hilly character, and of a somewhat forbidding aspect.

In the neighbourhood of Saint John, as observed by Mr. Matthew, they, with the succeeding group, constitute the ridge lying between the City and Kennebeckasis Bay, and their surface is "diversified by numerous lakelets and ponds." Their general aspect is familiar as exposed in the Narrows of the Saint John River above the Falls.

To the eastward they attain a somewhat greater elevation, but still preserve their general character. To the westward between Carleton and the boundary of Charlotte, they rise in low bare ridges of syenite and limestone, but exhibit no features of special interest.

Agricultural Capabilities.—As may readily be inferred from their topographical features, the land underlaid by the Portland rocks is not of a fertile character. Even the superficial covering of drift is generally wanting, and as the rocks are of a kind but slowly acted upon by the influence of the weather, the soils produced are almost without exception of an inferior quality.

Useful Minerals.—The two most important and valuable minerals in the Portland rocks, are limestone and graphite. The existence of each of these has been long known, and the former, especially, has been profitably worked. The following are the principal localities where the beds occur. They are also indicated upon the map by streaks of a bright blue colour.

a. Narrows of the Saint John River, on both sides.
b. Portland.
c. From the Suspension Bridge for several miles easterly, north of the Marsh Creek.
d. Near Sandy Point, and in the Islands called the Brothers.
e. Drury's Cove in thick beds.
f. Near and southwest of Torryburn Station. } Continuations of the Sandy Point beds.
g. At Quispamsis.
h. Southeastern side of Long Island. Kennebeckasis Bay.
i. West side of South Bay.
j. Peninsula of Pisarinco. North side of Mill Creek.
k. " " East side of Musquash Harbour.
l. West side of Musquash Harbour? This *may* be Devonian.

The limestones of Portland, as well as those of Lily Lake and other localities in this group of rocks, frequently hold veins of the mineral Serpentine, the admixture of the two giving rise to the ornamental "verde antique." The limestone also is often beautiful, but the difficulty of procuring slabs of either, sufficiently perfect, render them unfit for manufacturing purposes.

The graphites of the Portland Series have already been alluded to, and, as regards their principal locality, Portland, have been well described in the remarks of Principal Dawson. They are very characteristic of the group in its upper beds, and may usually be seen where the latter are exposed. Besides the locality at Portland, they have been observed at Queen's Lake, in the valley of Coldbrook, eastward of Saint John, and also at Lily Lake and Drury's Cove. They are too impure to be of much economical value.

On the western side of the main River, no distinct beds of graphite have been observed. In the peninsula of Pisarinco, however, there are many rocks which owe their dark colour to the presence of this mineral.

As a metalliferous series, the Portland Group is almost wholly without interest. It has been found to contain the sulphurets of iron, copper and lead at several localities, but the quantity of these metals is too small to deserve any special notice.

COLDBROOK GROUP.

Distribution.—It has already been stated that the rocks of the Portland Group, forming a portion of the hilly and rugged land to the north and northwest of Saint John, constitute an anticlinal, on the southern slopes of which repose formations of progressively later and later origin. The first of this series, immediately overlying the Portland beds, is the group now under consideration. It consists of two members, an upper and a lower, the latter being a hard greenish compact slate, of volcanic origin, the latter soft, and as a rule, bright red, its origin being purely aqueous. In studying the distribution of the group, one or both of these members may occur.

In the neighbourhood of Saint John, the rocks of the Coldbrook Group are poorly represented. At the Falls of the main River, according to Mr. Matthew, they do not exceed a thickness of 150 feet, and back of the City, from which they are separated by the Valley and Marsh, they are also of small extent. They here rise into a commanding ridge, and in general throughout their entire distribution preserve this character, being considerably elevated above the general level of the country.

Following the group to the eastward, this band, represented by both members, maintains a nearly uniform width along the line of the Marsh Creek. At the Coldbrook Iron Works, and along the stream of the same name, the surface area occupied by these rocks begins to widen, and continues to do so, attaining its greatest development towards the foot of Loch Lomond. On the northern side of this sheet of water, the rocks of the lower member rise into hills of considerable elevation, including Ben Lomond

and other eminences, and have been traced to the eastward as far as the third Lake. Throughout this portion of their development they have an almost invariable southerly dip of 70°.

Their northern limit is a nearly uniform line stretching from the Falls in Portland, through the Golden Grove Settlement, to near Barnesville. Their southern limit has been traced in a line curving southeasterly along the valley of the Coldbrook, and extending to the southern extremity of Loch Lomond, where the upper (red member) is chiefly represented. Deposits, probably referable to the same member, occur along the south side of the first Lake, beyond which they are not immediately apparent.

In attempting to trace the further distribution of the Coldbrook Group, several perplexing difficulties immediately arise. To the eastward, deposits probably referable to this series occur, but the gradual increase of later formations obscure their relative position, and prevent the tracing of isolated areas into direct connection. Secondly, to the southward great irregularities prevail, which perplex, though they do not wholly obscure, observations made in this quarter. These irregularities will be better understood after some reference shall have been made to the overlying groups. It is sufficient here to say, that owing to the existence of an extensive fault, and a synclinal fold of the Coldbrook rocks, the latter reappear a few miles southward of Loch Lomond, and again occupy an extensive area.

Beginning in the neighbourhood of Otter Lake, the upper (red) member of the group appears, and the rocks are well exposed in a section made by the valley of Ratcliffe's Mill Stream. They thence extend to the eastward and are again met, occupying a somewhat broader area in the neighbourhood of Hanford's and Harding's Brooks, on the road from Quaco to Sussex. In these last named localities, as well as at Ratcliffe's Stream, their dip is northerly, thus indicating, as is also shown by other circumstances, a complete reversal of the series.

The cause of such reversal at Ratcliffe's Mill Stream, is apparent in the long ridge of eruptive syenite, (indicated by a colouring of bright red,) which extends southward of the above named rocks, from Negro Lake as far as, and perhaps beyond, the Parish line between Simonds and Saint Martins. This eruptive ridge now marks the line of a fault and downthrow, for on its southern side we have again the older member of the Coldbrook series, the upper and lower beds being thus brought to the same level. The latter extend from the Negro Settlement, near the sources of Black River, far to the eastward, as indicated upon the map. They are passed over on all the principal roads to Quaco, and extend an unknown distance into the wild lands south of the Shepody Road.

As in all the older groups, the rocks of the Coldbrook series are progressively covered and obscured to the eastward by Carboniferous deposits. It is therefore difficult to define their limits with precision. Allowing for irregularities due to this cause, the southern boundary of the group would be a somewhat waving line, extending from the Negro Settlement across the

sources of Gardner's and Ten Mile Creeks to a point on Vaughan's Brook, about four miles northeast of Quaco.

At several points in the Parish of Hammond, stratified volcanic rocks are found, which are probably representatives of the group now under consideration. Of these there are two principal ridges, the first crossing the Parish line between Upham and Hammond, just south of the Hammond River, and reappearing near the Manganese mine of Mr. Davidson; the second, northward of the last and indicated only by boulders, occurring in the southern portion of the Parish of Sussex. It is in the former of these that lead has recently been discovered, as hereafter noticed.

CHARACTERS.—It has been stated that the Coldbrook Group consists of two members, an upper, soft, red, and of aqueous origin, and a lower, in which the rock is chiefly a hard greenish-grey compact slate. There is but little variation in the characters of these members throughout their entire extent.

In the neighbourhood of Saint John the development of the group is of too limited a character to serve for illustration. Widening however to the eastward, it is well exposed along the valley of the Coldbrook, and the following succession has been observed by Mr. Matthew:—

1. Hard greenish-grey slate, stratification very obscure.
2. Conglomerate, with bright red slaty paste.
3. Grey conglomerate.
4. Coarse reddish grit, and conglomerate with purple sandstone. Apparent thickness of the whole, 5000 feet.

In tracing the group to the eastward, along the northern side of the Loch Lomond Lakes, two sections have been made across the lower member of the series, the first extending from "the Thoroughfare" between the first and second Lakes, to the Golden Grove Settlement, the second from the latter to the third Lake, thus recrossing the same ridge.

Along the line of the first section, the rocks of the group differ from their development to the westward, chiefly in the occurrence of a middle band of sandstone and shale, resting upon a thick succession of porphyritic and amygdaloidal traps, associated with bands of ferruginous and white felspathic quartzites. Near the lower part of Golden Grove, the base of the Coldbrook Group is represented by the occurrence of heavy beds of dark grey sandstones and coarse quartzose conglomerates, the latter much faulted and injected.

The great thickening of the Coldbrook beds in this vicinity is probably, as suggested by Mr. Matthew, the cause of the decided easterly trend noticeable in the upper member of the present group, as well as in the overlying deposits.

Along the second section referred to, no facts additional to those now given were observed, with the exception that a portion of the series near Brawly Lake has been exposed by an extensive slide, and now projects in wild and lofty overhanging cliffs above the ruin at its base.

It has been stated that rocks apparently forming a portion of the upper member of the group now under consideration, occur along the southern side of the first Loch Lomond Lake. They consist of purplish-red trappean and quartzose sandstone, but are not well exposed. Although probably belonging as above stated, it is possible that these rocks may represent the upper member of the Bloomsbury Group, hereafter to be described.

Southward of the above, along the line of Ratcliffe's Mill Stream, the exposures are more clearly visible, and the Coldbrook rocks may be again distinctly recognized. Nominally underlying the Saint John Group, which is a newer series, they here lie above the latter, both formations having been reversed by a folding of the strata. They consist at this place of purple sandstone, greenish-grey, red and purple sandy shales. To the eastward the same member appears crossing Hanford's and Harding's Brooks, on the old road from Quaco to Sussex.

Returning for a moment to the neighbourhood of Loch Lomond, we have next to consider the rocks of this group, occurring to the southward of the fault and downthrow at the Negro Settlement. Near the last named place, and resting upon a ridge of eruptive syenite, Mr. Matthew has observed a series of compact slaty traps, with beds and dykes of greenstone, these in turn being overlaid by a broad band of white and pink felspathic and silicious slates. Upon them again repose a series of heavy ash-slates and amygdaloidal traps, forming the northern side of the valley of Black River. On the southern side of the latter, beds of the Saint John Group appear.

In the sequence of volcanic sediments detailed above, a close resemblance is apparent to the similar succession already given on the north side of Loch Lomond. The same sequence is also apparent along the old road to Quaco, being especially noticeable in the occurrence in each of fine pink felspathic quartzites, succeeding blueish, pink and grey porphyritic slates.

A consideration of the volcanic ridges in the Parish of Hammond, doubtfully referred to the present group, will be postponed to the section on their mineral contents.

AGE.—The facts upon which depend the determination of this question, have already been given in the remarks on the age of the Portland Series, where also a parallelism is suggested between the Coldbrook rocks and those of the Huronian Series of Canada. The parallelism is apparent, partly in the fact that the former, like the latter, underlie the rocks of the Potsdam Group, (of which the Saint John slates are here the representative,) and partly in their mineral characters and the absence of fossils.

It is impossible to read the description given of the Huronian Series in the reports of the Canadian Survey, without being struck by the close resemblance which exists between the members of that series, and what has been termed in New Brunswick the Lower Coldbrook Group. In both the prevailing rock is a hard compact slate, almost universally of a dull greyish-green colour, with which are associated pink and white, or greenish-white felspathic quartzites, and at the base of the series, dark grey sandstones and

conglomerates. In both, also, dioritic or greenstone dykes are common, as well as stratified amygdaloidal traps, the igneous outflows penetrating the rocks as well as lying in regular beds among the strata, in which they have produced excessive alteration. It will thus be seen, that the two formations are alike in their general character, as well as in the conditions under which they were produced. Indeed, the resemblance is much stronger than would naturally be expected in series so widely separated.

In passing to the upper member of the Coldbrook Group, the task of establishing a parallelism with either of the Canadian series is much more difficult. Unless we regard the red quartzites and jasper-conglomerates of the Huronian rocks, (Nos. 7 and 8 of the section given in the Canadian Reports, near the Thessalon River,) as the equivalents of the red conglomerates and sandstones of the New Brunswick Group, no rocks approaching the latter in character are found, with the exception of the red sediments associated with the copper bearing rocks of Lake Superior. As these, however, have been shown to be the probable equivalents of the Chazy Group, which occupies a higher horizon than the Potsdam beds, which here overlie the rocks of Coldbrook, we must, for the present, be content to consider their precise position as uncertain, only remembering that they constitute a series lower than the Primordial rocks, at the base of the Silurian.

Topographical Features.—It has already been stated that the lower member of the Coldbrook Group, being of volcanic origin, and composed of hard and compact rock, projects as a rule above the general level of the country. This character it preserves throughout, and has, perhaps, more than any other series, conferred irregularity and diversity on the scenery of the southern Counties.

The prevalent direction of the ridges representing this group is, like most of those in this portion of the Province, a little north of east. These ridges are for the most part of considerable elevation, have steep and frequently precipitous sides, forming the water-sheds of numerous streams, and may in general be recognized by their rough and forbidding aspect. Along the north side of Loch Lomond they constitute some interesting scenery, being exposed in perpendicular cliffs along the margin of the Lake, including Ben Lomond and other peaks. Rocks of this group also constitute the high lands north of Quaco. The upper member of the Coldbrook, being of much softer material, and therefore more readily removed by denudation, exhibits no topographical features worthy of special notice.

Agricultural Capabilities.—Although at times well wooded, the soil underlaid by rocks of the Coldbrook Group, can scarcely be considered fertile, and settlements are almost entirely wanting where these rocks occur. Some improvement is, however, manifest where the upper aqueous sediments prevail.

USEFUL MINERALS.—So far as known, the volcanic sediments of the Coldbrook Group do not abound in useful minerals, and few localities are known where the latter exist in profitable quantities. The nature of the group, however, and the evidence which it affords of volcanic activity during the period of its accumulation, are favourable to the existence of such deposits, and the discoveries already made are of such a character as to justify the belief that the series as a whole will yet be found to be a profitable one.

Allusion has already been made to a ridge of volcanic rock, lying along the southern side of the Hammond River in the Parish of Upham, in which has recently been made a discovery of lodes containing lead and copper. This locality has been visited by our party, and the following observations made upon its probable value.

The locality referred to is situated at a distance of about one mile from Wanamake's Inn, on the road from Quaco to Sussex, the Hammond River, here navigable for small boats, passing between the road and the mine. The latter was found to be situated in a vein or lode of white quartz, running about northeast and southwest, bending around, however, to a course about N. 20° W. The lode at the point examined is about one foot thick, well crystallized, and holds numerous veins, but principally detached crystals, of galena, with a few small patches of yellow sulphuret of copper.

The mass of the hill in which the lode occurs is composed of porphyritic and amygdaloidal traps, with some ash beds. It is probably intrusive in part, if not wholly; but its position and general character serve to ally it with the volcanic beds of the Coldbrook, and it has therefore been grouped with that series.

With regard to the probable value of the deposit in question, it is our opinion that, considering all the circumstances of its position, this bed of ore is not likely to prove remunerative. This opinion is chiefly based upon the following facts:—

1st. The country rock, a stratified volcanic series, is not favourable to the development of lead in quantity.

2nd. The lode stone, crystalline quartz, is also an unfavourable matrix for the above named metal, and is moreover very costly for development.

3rd. The presence of copper, should it prove to be abundant, may confer upon the deposit a value which the lead alone, though argentiferous, would not give. So far as known however, the amount of the former metal is but small.

The locality is at present rather inaccessible, the ground being entirely uncleared. The lode occurs in the bottom of a ravine, exposed during the dry season, but has also been observed with similar deposits of lead at other localities in the neighbourhood.

In addition to the locality above described, and which is with some uncertainty referred to the present series, ores of iron have been observed in undoubted Coldbrook rocks by Mr. Matthew at several points to the eastward of Saint John. One of these localities is at Henry's Lake, near Quaco,

on land owned by H. Horton, where beds of this group contain specular iron in seams; another, of greater extent and value, the particulars of which may be obtained from Mr. Matthew, occurs at a different locality, and is capable of yielding 50 per cent. of the same metal.

PALAEOZOIC TIME.

From the Azoic Rocks, destitute of all but the very humblest forms of life, we pass to the consideration of the next great cycle in geological history, known as the Palaeozoic or Ancient Time, including a succession of ages, in which this portion of the continent underwent a variety of physical changes, and when the organic world, though far advanced in the number, type and size of its animals and plants, beyond what had previously existed, was still very unlike the present creation.

These ages into which the Palaeozoic or Ancient Time is usually divided, are three in number: 1st, the Silurian, in which molluscous forms of life prevailed, and when this portion of the continent was largely beneath the ocean; 2ndly, the Devonian, when Fishes, the lowest of Vertebrates, were added, and the land became gradually elevated to form marshes and dry land; and 3rdly, the Carboniferous, or Age of Coal Plants, when these marshes became more and more extensive, and were clothed with an abundant vegetation, the accumulated remains of which, altered and solidified, now constitute our beds of coal.

As the limits of these ages have not yet been clearly marked in Southern New Brunswick, they will be described in connection, under the local names already assigned to the several groups.

SAINT JOHN GROUP.

Distribution.—The present group, constituting the second series of sedimentary deposits, southward of the Portland anticlinal, occupies a position nearly parallel to the Coldbrook beds, and follows the latter in their course to the eastward.

a. Crossing the main river a little below the Suspension Bridge, the rocks of the present series underlie the greater portion of the City, from which their name has been derived. Separated by the valley of the Marsh, from the older member of the Coldbrook series, they rise in the City of Saint John to a considerable elevation, and are well exposed in the sections furnished by the grading of the streets. They do not, however, underlie the entire area of the City, being overlaid towards the harbour by rocks of Devonian age.

b. Reappearing on the eastern side of Courtnay Bay, and describing two gentle curves, the Saint John rocks maintain a nearly uniform breadth for several miles to the eastward, but narrow as they approach Loch Lomond. They reach the latter lake near its southwest extremity, and may be recognized also along its southern margin, but compared with their development to the westward, now occupy a limited area.

c. While thus diminishing and finally disappearing along their proper line of outcrop, the rocks of the Saint John Group, like their predecessors of the Coldbrook, reappear to the southward by a synclinal fold, and in this new line extend many miles to the eastward. In this portion of their development they occupy a much less prominent position than is the case to the westward, and being composed of soft materials, and therefore more liable to denudation, they occur principally along the valleys, and have been much obscured by the accumulation of superficial detritus. It is only where the latter has been removed by the agency of running water, that the series can be at all studied. We have found the rocks of the group to be well exposed at Ratcliffe's Millstream, and also a few miles to the eastward along the valley of Hanford's and Harding's Brooks, in the southern part of the Parish of Upham. In the first of these localities they are associated with and overlaid (in consequence of an overturned dip,) by rocks of the Coldbrook Group, as already noticed.

To the eastward of the last mentioned localities, no undoubted outcrops of the Saint John Group have been observed, and from the gradual thinning-out which is apparent in this direction, they are hardly to be expected. It is possible, however, that some portion of the group may be represented among the slates of Albert County.

d. Reference has already been made, in the remarks on the Coldbrook Group, to the re-occurrence of the present series, in the valley of Black River, near the Negro Settlement, south of Loch Lomond. The discovery of this most important fact has thrown much light on the complicated relations of the deposits in that vicinity.

e. In the remarks on the distribution of the Portland Series, it has been stated that at Long Island, in Kennebeckasis River, rocks of great age, consisting of granite, gneiss, limestone, and slate, appear, and are undoubtedly referable to the Portland Group. Reposing upon the latter at the same locality are finely laminated shales, which from their texture and the presence of obscure remains, have been doubtfully referred by Mr. Matthew to the Saint John Group. They reappear at Sand Point, six miles southwest, and will be again referred to.

f. Westward of the Saint John River, the rocks of the group appear and occupy a considerable portion of Carleton. Their thickness in this direction rapidly diminishes, and beyond the last named locality they have not been recognised.

CHARACTERS.—In the tabular list of formations on page 8, the Saint John Group has been described as consisting of "several zones of soft black and dark grey laminated shales, alternating with zones of coarser grey slates, containing numerous thin beds of fine grained sandstone." The great mass of the deposit as developed in Saint John, where it has been most minutely studied and described by Mr. Matthew, "consists of a grey clay-slate, often sandy, the layers of which present glistening surfaces owing to the abundance of minute spangles of mica. This rock frequently becomes very fine in lamination and texture, and dark in colour. Four thick bands of this kind occur, the uppermost of which has been denominated by Dr. Dawson "papyraceous shale." The three bands of coarser shale which alternate with them, include numerous layers of a fine compact grey sandstone, from a few inches, to ten feet or more in thickness; a few are so highly calcareous as to become almost limestones. The surfaces of the layers in the coarser bands are frequently covered with worm-burrows, ripple-marks, shrinkage cracks, scratches—apparently made by creatures gliding through the shallow waters in which they were deposited—and other evidences indicating that the slates are in great part of littoral origin."

The thickness of the group as measured near Saint John, has been stated as 3,000 feet or more. No fossils were here recognised with the exception of an obscure mollusk, termed a *lingula*.

In tracing the Saint John Group to the eastward, the most noticeable change is in the marked diminution of the numerous thick beds of fine sandstone which add so much to the firmness and thickness of the beds near the City, and the gradual decrease in the superficial area occupied by these rocks. At the same time that they thus assume a position of less importance in the topography of the district, they greatly increase in the value of the conclusions to which their study leads, and throw much more light than in their development to the westward, on the circumstances of their original formation.

Allusion has already been made to a section of this and the underlying group, furnished by the valley of Ratcliffe's Millstream, south of Loch Lomond, and on the old road to Quaco. As the locality has proved to be one of especial interest, it will now be described in some detail.

The stream referred to, descending in a northerly direction from a high ridge of eruptive syenite, flows obliquely across the strata at its base, forming a ravine and fall of considerable beauty. In this ravine, five miles below Loch Lomond, are well exposed the upper sediments of the Coldbrook series and the lower portion of the Saint John Group. The strata appear in nearly perpendicular beds, and as before stated, give conclusive evidence of a complete reversal in the two series. This will be more readily apparent from a study of the annexed ideal section, designed to represent the relations of the several groups as developed at this locality.

It will be remembered that the Saint John Group is a newer series than the Coldbrook, and in its normal position overlies the latter. This is repre-

sented on the left of the section, where the several groups occur in the order of their natural succession. North of Loch Lomond we have the high ridge of the Lower Coldbrook (A), the upper member (B) being apparent at the southwest extremity of the Lake, and probably occupying its depression. In both the inclination is to the south, the former at an angle of seventy, the latter of sixty degrees.

Passing to the southern shores of the Lake, we meet the soft beds of the Saint John Group (C), like the former, dipping southerly, but at a higher angle. Between the Lake and ravine on Ratcliffe's Stream no exposures occur, but at the latter the following succession has been observed:—

C	1st. Fine black slaty shales—Dip 50° S.—Strike N. 85° E. In the same beds there is an abnormal strike of S. 65° E. The true strike is resumed with a dip of 80° Southerly.	
B	2nd. Grey shales, holding trilobites and brachiopods. 3rd. Coarse grey shale, and hard grey sandstone. 4th. Purple sandstone and sandy shale (at the falls). 5th. Greenish grey and purplish shales and sandstones. 6th. Red and purple shales, with a bed of conglomerate.	Strike N. 60–65° E.—Dip 90°.

Of the rocks above mentioned, Nos. 1, 2 and 3 represent the beds of the Saint John Group, while 4, 5 and 6 are deposits of the Coldbrook. It will be observed that the latter, though conformable, or nearly so, now overlie the former, their position being just the reverse of that seen to the northward, and therefore indicating an overturn of the series. The cause of this disturbance and reversal is plainly evident in the ridge of eruptive syenite (D), against which the formations rest, and where, along the line of contact, there has been an extensive fault and downthrow. Some idea of the extent of this disturbance, as well as of the amount of material subsequently removed by denudation, will be apparent from the dotted lines which indicate the continuation of the beds. As usual, the downthrow is on the northern side of the fault or fissure, and the lower member of the Coldbrook has thus disappeared from sight. South of the eruptive band the series of rocks is again represented in their true succession.

The remaining exposures, enumerated in the remarks on the distribution of the Saint John Group, do not require special notice in this connection.

Age.—The question of age in the Saint John series, is one of great importance, throwing light, as it does, upon the origin of all the associated groups. It has been our fortune to discover facts which leave this question no longer doubtful.

It has already been remarked, when describing the character of this series as developed in the City of Saint John, that the remains of a Lingula, an animal related to our modern shell-fish, had been found to characterize in considerable numbers some of the sandy beds, but that they were too imperfectly preserved, and too indecisive in their character, to throw any positive light upon the age of the rocks which hold them. The other markings before mentioned, such as worm-burrows, shrinkage-cracks, and rain-drop impressions, although they furnished conclusive evidence as to the physical conditions under which the beds were formed, did not serve to remove the obscurity which enveloped the discussion of their age.

Subsequently, during an examination of the valley of the Coldbrook by Mr. Matthew and his brother, organic remains were observed of a more decided character. These latter consisted, besides some obscure relics, of a small orthoceratite, and numerous trilobites of two or three species, but these were so excessively distorted that no satisfactory conclusions could be based upon their study. Until the present summer, therefore, the age of this great series, although vaguely surmised, remained a subject of discussion and doubt. The discovery of finely preserved Trilobites and Brachiopods at Ratcliffe's stream, and in the valley of the Coldbrook, has now removed this doubt, and left no uncertainty as to the age and origin of the group which holds them. We regard this discovery as among the most interesting and valuable results of our summer's labour.

That the discussion of this question might have the careful and attentive study which its importance demanded, the fossils above referred to were placed in the hands of Mr. Hartt, who, as will be seen below, has enjoyed peculiar facilities for their determination and comparison. It had been hoped that the entire results of that gentleman's labours might have been embodied in the present Report, but the want of sufficient leisure for their complete analysis, has prevented this from being accomplished. The following notice is, however, introduced as preliminary to a more detailed description to be given hereafter:—

Preliminary Notice of a Fauna of the Primordial Period in the vicinity of St. John, N. B.
By C. Fred. Hartt, A. M.

My examination of the fossils collected last August, from the Saint John Group, at Ratcliffe's Millstream, by Prof. Bailey, Mr. Geo. Matthew, and myself, and of a collection made from the same group at Coldbrook, in 1863, by Messrs. Geo. and C. R. Matthew, is not yet sufficiently complete to enable me to give an extended description of them here. I shall, therefore, limit myself, at present, to a notice of the genera, and of the aid they afford in the determination of the geological position of the Saint John Group, leaving the descriptions and figures of the species to be given in a paper which will appear in the Appendix to this Report.

The fossils as yet known to occur in the rocks of the Saint John Group, are principally Trilobites, which are represented by quite a large number of species, and Brachiopoda, which last are of more rare occurrence. All these fossils are preserved as casts or impressions, the tests of the crustacea and the shells of the Brachiopoda being usually transformed into oxide of iron.

All the specimens have suffered more or less from distortion through pressure and the metamorphosis to which the rocks enclosing them have been subjected. The Trilobites occur also as detached fragments, so that their accurate determination is not easy, and more material is required in order satisfactorily to figure and describe all the species.

Representatives of four genera of Trilobites have been obtained thus far from the Saint John rocks, viz:—*Paradoxides*, *Conocephalites*, *Agnostus*, and *a new genus?* allied to *Conocephalites*.

The number of species in each genus has not yet been satisfactorily made out; but of *Paradoxides* there are at least five, of *Conocephalites* seven, and of *Agnostus* and the *new genus* each one.

All the species appear to be new. One of the *Paradoxides* bears a close resemblance to *P. rugulosus*, Corda, from the *Etage* C of Barrande, in Bohemia, and one of the *Conocephalites* is allied to *C. coronatus*, Barrande, from the same fauna and horizon, though neither is identical with the European species.

There are six species of Brachiopoda, belonging to the genera *Orthisina*, *Discina*, *Obolella*, and *Lingula*. I have not been able to identify any of the forms with described species.

Though all the species from the Saint John group are apparently new, yet the occurrence of *Paradoxides* and *Conocephalites*, genera confined entirely to the so called *Primordial fauna* of Barrande, and everywhere characteristic of it, together with the strong likeness borne by the Saint John species, in their facies, to those of the same genera of the faunæ of the "Primordial" in Europe and America, enable us unhesitatingly to assign to the Saint John group, or at least to that lower part of it which has afforded Trilobites, a geological position equivalent to Barrande's Etage C, or to the Potsdam proper of America.

As Agassiz has shown, Barrande uses the word *fauna*, in his term *primordial fauna*, in a sense equivalent to *epoch* or *horizon*. A fauna is strictly a collection of animals confined within a limited geographical area. The terms "primordial fauna," "second fauna," are used with propriety when applied to the groups of fossils characterizing the Etages C and D in Bohemia; but these terms, unless limited, should not be extended to equivalent groups of the same age, but forming distinct faunæ, in other parts of the world, for such a *double emploi* is incompatible with that precision which should mark the use of scientific terms. Primordial *zone* is objectionable. If the term Primordial is used, and it is very appropriate, it would be much better to say Primordial *Period*, period as used by Agassiz, being equivalent to Barrande's *etage*.

The lower part of the Saint John Group, at Coldbrook, has been divided by Mr. Matthew on lithological grounds, into three Bands, viz:—

No. 1. The lower or arenaceous band, with no determinable fossils, and constituting passage beds from the Coldbrook Group.

No. 2. Argillaceous shales, rich in fossils, *Paradoxides*, *Orthisina* ?, *Conocephalites*, *Obolella*.

No. 3. Carbonaceous shales, full of fossils, *Paradoxides*, *Conocephalites*, *Orthisina*, *Discina*, &c., all much distorted.

I have not observed No. 2, at Ratcliffe's Millstream. No. 3, at Coldbrook, corresponds exactly, in its fossil remains, to the bed at the Millstream, from which the Trilobites, &c., were obtained. Nearly, if not all the fossils I have seen from No. 2, at Coldbrook, are entirely distinct from those of No. 3 of the same locality and the Millstream; but more material is required to establish the claim of these two beds to be considered as being characterized by distinct successive faunæ. At all events, all the species from both beds are different from those elsewhere occurring, and for at least bed No. 3, we have in the vicinity of Saint John a distinct fauna of the Primordial Period.

Through the kindness of Prof. Agassiz, under whose supervision my work is being done, and to whose suggestions I am largely indebted, I have been able to compare my specimens with the fine suite of Bohemian and other primordial trilobites in this Museum. The results of these comparisons I shall leave to be brought out in my forthcoming paper.

Museum of Comparative Zoology, Cambridge, Mass.

TOPOGRAPHICAL FEATURES.—It has already been remarked that the beds of the Saint John Group, consisting for the most part of soft materials, have been more subject to the effects of denudation than the deposits which over or underlie them. While the latter, by their greater firmness, have resisted the wear of running water, and now project in ridges above the general level of the country, the former have been washed away, and if not entirely disappearing, are found chiefly along the valleys and depressions.

It would, at first sight, seem that the statement above made is directly contradicted by the prominence of the group in the City from which it takes its name. A slight examination of the map, however, will serve to show that even here, although the hills composed of this group, and underlying the City, attain a considerable elevation, they have suffered more than the associated groups, by denuding agencies, and only appear elevated by con-

trast with the water which surrounds them. The entrance of the Saint John, the valley of Courtnay Bay, and the depression of the Marsh Creek, are all due to the removal of the soft beds of the Saint John Group. The latter occupies one branch of a valley extending along the line of Loch Lomond far to the eastward, being, between the City and the Lake, shut in on either side by the volcanic streams of Coldbrook and Bloomsbury. As remarked by Mr. Matthew, advantage has been taken of this depression to supply the City with water from lakes in the vicinity of Loch Lomond.

A more striking illustration of the extent to which this group has been denuded is furnished by the occurrence, already alluded to, of a few detached areas of Saint John rocks, at several points in the valley of the Kennebeckasis. The texture and position of these latter, as well as their obscure fossils, were early recognised by Mr. Matthew, as proof of their identity with the beds which underlie the City, and the same gentleman has thus been led to adopt the very important conclusions: first, that a belt of finer sediments, similar to those seen on the southeastern side of Saint John, was originally deposited on the northwest of the Portland Series; and secondly, "that the valley of the Kennebeckasis, now almost entirely filled with carboniferous deposits, was originally scooped out of the soft beds of the Saint John Group."

The amount of denudation implied in this last statement can only be appreciated by those who understand the quality and thickness of the denuded beds, and the immense size and depth of the valley which they occupied.

Agricultural Capabilities.—The rocks of the Saint John Group, where prominently developed, as in the neighbourhood of the City, are seldom covered with soils of fertility. As the general distribution of the series, however, is along the bottoms of extensive valleys, frequently drained by rivers, the area occupied by these beds is well covered with superficial detritus, and thus possesses a value which the nature of their own decomposition would not confer.

Useful Minerals.—As far as known, the rocks of the Saint John Group are entirely destitute of useful minerals. Iron pyrites is abundant in the slates, especially near the Suspension Bridge, but is not of economic importance.

There are six species of Brachiopoda, belonging to the genera *Orthisina*, *Discina*, *Obolella*, *and Lingula*. I have not been able to identify any of the forms with described species.

Though all the species from the Saint John group are apparently new, yet the occurrence of *Paradoxides* and *Conocephalites*, genera confined entirely to the so called *Primordial fauna* of Barrande, and everywhere characteristic of it, together with the strong likeness borne by the Saint John species, in their facies, to those of the same genera of the faunæ of the "Primordial" in Europe and America, enable us unhesitatingly to assign to the Saint John group, or at least to that lower part of it which has afforded Trilobites, a geological position equivalent to Barrande's Etage C, or to the Potsdam proper of America.

As Agassiz has shown, Barrande uses the word *fauna*, in his term *primordial fauna*, in a sense equivalent to *epoch* or *horizon*. A fauna is strictly a collection of animals confined within a limited geographical area. The terms "primordial fauna," "second fauna," are used with propriety when applied to the groups of fossils characterizing the Etages C and D in Bohemia; but these terms, unless limited, should not be extended to equivalent groups of the same age, but forming distinct faunæ, in other parts of the world, for such a *double emploi* is incompatible with that precision which should mark the use of scientific terms. Primordial *zone* is objectionable. If the term Primordial is used, and it is very appropriate, it would be much better to say Primordial *Period*, period as used by Agassiz, being equivalent to Barrande's *etage*.

The lower part of the Saint John Group, at Coldbrook, has been divided by Mr. Matthew on lithological grounds, into three Bands, viz :—

No. 1. The lower or arenaceous band, with no determinable fossils, and constituting passage beds from the Coldbrook Group.

No. 2. Argillaceous shales, rich in fossils, *Paradoxides*, *Orthisina ?*, *Conocephalites*, *Obolella*.

No. 3. Carbonaceous shales, full of fossils, *Paradoxides*, *Conocephalites*, *Orthisina*, *Discina*, &c., all much distorted.

I have not observed No. 2, at Ratcliffe's Millstream. No. 3, at Coldbrook, corresponds exactly, in its fossil remains, to the bed at the Millstream, from which the Trilobites, &c., were obtained. Nearly, if not all the fossils I have seen from No. 2, at Coldbrook, are entirely distinct from those of No. 3 of the same locality and the Millstream; but more material is required to establish the claim of these two beds to be considered as being characterized by distinct successive faunæ. At all events, all the species from both beds are different from those elsewhere occurring, and for at least bed No. 3, we have in the vicinity of Saint John a distinct fauna of the Primordial Period.

Through the kindness of Prof. Agassiz, under whose supervision my work is being done, and to whose suggestions I am largely indebted, I have been able to compare my specimens with the fine suite of Bohemian and other primordial trilobites in this Museum. The results of these comparisons I shall leave to be brought out in my forthcoming paper.

Museum of Comparative Zoology, Cambridge, Mass.

Topographical Features.—It has already been remarked that the beds of the Saint John Group, consisting for the most part of soft materials, have been more subject to the effects of denudation than the deposits which over or underlie them. While the latter, by their greater firmness, have resisted the wear of running water, and now project in ridges above the general level of the country, the former have been washed away, and if not entirely disappearing, are found chiefly along the valleys and depressions.

It would, at first sight, seem that the statement above made is directly contradicted by the prominence of the group in the City from which it takes its name. A slight examination of the map, however, will serve to show that even here, although the hills composed of this group, and underlying the City, attain a considerable elevation, they have suffered more than the associated groups, by denuding agencies, and only appear elevated by con-

paratively rare, and when occurring, are sometimes chloritic and sometimes micaceous, being also, as a rule, much twisted. Like the members of the first division, these rocks also contain chlorite and epidote. The group may be readily seen in the village of Kingston, or along the Land's End at the southwest extremity of the peninsula.

The third band, into which the last insensibly passes by the absence of its bedded diorites, occupies principally the northern side of the peninsula, where it is represented by a comparatively uniform series of clay and chloritic slates. Though not so numerous as in the centre and south of the district, trap beds are present, and at times rise into bold ridges. This is especially the case near the middle of the Reach, where they produce some interesting scenery.

DISTRIBUTION.—The rocks of the Kingston Group, besides occupying the peninsula which properly bears that name, extend to the eastward within the limits represented on the map. Like most of the older formations in this part of the Province, they are progressively covered to the eastward by carboniferous rocks. They extend, however, on the south as far as Dickie Mountain, near Norton Station, and upon the north within a few miles of Belleisle Point, forming two bands, separated by a valley now occupied by Sub-carboniferous sandstones and limestones.

On the northern shore of the Long Reach, lying between the main River and the granites of the Nerepis, is a band of rocks which I have, with some doubt, referred to the group now under consideration. I have not been able to examine this district in sufficient detail to fully establish its relative age, but have connected it with the Kingston rocks, for the following reasons:—

1st. At the extremity of Oak Point, towards the head of the Reach, and in the rocky Islands occurring in this neighbourhood, the beds are undoubtedly connected with those of Kingston. At Oak Point two varieties occur, interstratified with each other.

a. Very hard, dark-black and green bedded diorite, with calc spar, chlorite, and epidote.

b. Light coloured fine-grained felspathic rocks, graduating into coarser beds of syenite and syenitic gneiss. (General strike, N. 50° E., Dip V ?) These latter are undoubtedly altered sandstones and conglomerates.

2nd. Rocks similar to the above seem to form a well defined band extending westward as far as the Nerepis. At Jones' Creek they are well exposed in thick beds, and apparently rest on a still thicker series of blue and grey altered slates. These latter are little disturbed, having a strike about east and west, and a southerly dip of 62°.

Along the line of the Nerepis, and in the neighbourhood of the Douglas Arms, altered rocks similar to the above in their granitoid aspect occur, and are probably a continuation of the same series.

Between these and the great granite range of the Nerepis valley, altered sandstones and slates, diorite, felsite, and cherty quartzite, occur.

It will thus be seen that the band of rocks now under consideration resembles those of Kingston, in the presence of felspathic and greenstone beds, while it differs principally in the abundance of coarse syenite, and syenitic gneiss. The rocks of Oak Point seem to be a connecting link between the two.

To the southwestward of the series last described, and directly opposite the termination of the Kingston peninsula, the nature and relations of the rocks are no longer doubtful. The abundance of pale pink felsites and felspathic quartzites, with beds of interstratified greenstone, at once recalls the rocks of Kingston, and indicates an extension of this series to the westward. Except along the line of the main River, however, their development in this direction is little known, the district being as yet wholly unsettled. Rocks probably forming a part of the same series appear far to the southwest, along the New River, in the County of Charlotte. These will be again referred to.

For the sake of comparison with the descriptions already given upon the eastern side of the River, the following series of observations is introduced, showing the succession of formations along the western side, extending from the granites of the Nerepis to the Suspension Bridge :—

1st. From Douglas Mountain nearly to the County line.—Granite.

2nd. From the County line to the Douglas Arms.—Altered sandstone, bedded greenstone, syenite, altered slate, cherty and felspathic quartzites.

3rd. From Douglas Arms to mouth of Nerepis.

a. Grey granitoid beds—syenite and syenitic gneiss, in thick deposits.

b. Green altered sandstones.

c. (At Nerepis Mills), Greenish and reddish altered slate.—Str. N. 40° E.—Dip V.

d. Diorite or greenstone in thick beds.

e. (Near mouth of Nerepis), Red slaty conglomerate, reddish sandstone and greenish sandstone of quartzite. These are in thick hardened beds and of coarse materials.

4th. From mouth of Nerepis to County line between Saint John and King's.—Felspathic rocks and quartzites, with bedded basalts, similar in every way to those of Kingston.—Str. N. 80° E.—Dip 72° N.

5th. Near the County line, and directly opposite similar beds in Kennebeckasis Island, the last named rocks are partly covered with a limited deposit of sub-carboniferous sandstone and conglomerate, red and crumbling, and resting unconformably on the underlying series.

6th. From the County line to the Suspension Bridge, the rocks as a whole are chiefly those of the Portland Group. Syenites become more abundant, and a gradual and insensible passage takes place from the rocks of Kingston to those of Portland. No marked transition is apparent, the line of division being probably indicated, and at the same time obscured, by the carboniferous deposits above described.

While the rocks of Kingston have thus been shown to occupy an extensive district, west and north of the Saint John River, along both shores of the Reach, observations in other localities would seem to indicate a corresponding easterly extension.

It has already been stated that, while occupying the entire peninsula from which their name has been derived, these rocks may be traced to the eastward in two diverging ridges, the one terminating at Dickie Mountain, near Norton Station, the other at a short distance below the head of Belleisle Bay. Stretching along the northern side of the latter, and forming the watershed between the tributaries of the Belleisle and Washademoak Rivers, is a ridge of rocks, somewhat variable in composition and of moderate elevation, which, though exhibiting some peculiarities, can with difficulty be distinguished from the deposits of Kingston and the Reach. As the series referred to is an extensive one, occupying the high land from the Saint John River eastward to within a short distance of Butternut Ridge, and as connected observations are here impossible from the abundance of superficial beds, and the gradual encroachments of carboniferous deposits, it will be best to describe its different localities separately.

Bull Moose Hill.—As composing the highest land in the ridge now under consideration, and also as best displaying the peculiarities of the series, if not itself constituting the volcanic vent to which the other deposits of the district owe their origin and character, Bull Moose Hill deserves our earliest attention.

The elevation to which the above name is commonly applied, which, however, is a collection of several hills, rather than a single well defined eminence, is as various in its composition as it is irregular in outline. The rocks which compose its mass are of three principal varieties;—

a. Metamorphic rocks, in part eruptive ?—syenite, hypersthenite, basalt, diorite.

b. Sedimentary beds—altered shales and sandstones, highly charged with volcanic products.

c. Carboniferous sandstones and conglomerates, unaltered.

Of the first named beds, the most abundant and most varied outcrops occur a little to the westward of the real Bull Moose Hill, on the farms of Messrs. George and William Northrup. At this locality, to which a detailed description is devoted in the Report of Dr. Gesner, the rocks are exceedingly various in texture, but less so in composition. They may for the most part be described as dioritic or greenstone rocks, (resembling syenite in general aspect and granular crystalline texture, but containing little or no quartz). They are tough, of a whitish colour, speckled with black and greenish-black, and graduate from varieties in which little distinction is apparent (except in colour,) between its constituent minerals, felspar and horneblende, to those in which the texture is very coarse, and the individual crystals large and prominent. Syenite and syenitic gneiss are also present, as well as some varieties of true granite. Some of the syenitic and dioritic beds are well filled with magnetic oxide of iron, constituting the so called "iron ore" described by Dr. Gesner. The latter will be again alluded to.

The *sedimentary* beds of Bull Moose Hill are best exposed along its summit and towards its southeastern side. They consist of grey altered grits, trappean slates, bedded traps, (partly vesicular,) and reddish grey micaceous sandstones. There are also beds which have the appearance of being composed of volcanic ash, and others (though less common,) of compact crypto-crystalline felspar.

On the eastern slope of the hill, at one or two points, are poorly exposed outcrops of green and purple mica slates.

The *carboniferous deposits*, resting unconformably on the older series, occupy principally the southeastern side of the eminence, rising nearly to its summit. They do not require further notice in this connection.

Belleisle Corner and Spragg's Brook.—Between the rocks of Bull Moose Hill and those observed in other portions of the Parish of Springfield, there is but little diversity, although in many parts the latter more nearly resemble the rocks of the Kingston peninsula, than is the case in the above-named eminence. They may be well seen at many points near the head of Belleisle Bay, but especially along the line of Spragg's Brook, near "The

Point," where they consist of interstratified compact and laminated felspars, altered slates, diorite, and syenitic gneiss. Near the source of the last named stream greenish and purplish mica slates, conformably overlaid by thick beds of slaty sandstone, were observed, and differ somewhat from any other rocks seen in this portion of the Parish. They occur along the summit of the high land north of the Belleisle, and near compact dioritic rocks, which seem to be a western prolongation of those of Bull Moose Hill.

In advancing to the eastward from the last named eminence, the same band of dioritic and syenitic rocks, with some true granite, and a small bed of limestone, is found to occupy the axis or centre of the elevated ridge dividing the valleys of Belleisle and Washademoak, as far as and beyond Kierstead Mountain, near Collina Corner. As at Bull Moose Hill, they are flanked on either side by sedimentary beds, consisting of clay and micaceous slates, compact and porphyritic felspars, interstratified with altered slates and grits. They are progressively covered with carboniferous deposits, which finally completely cap them, and at Butternut Ridge form the eastern termination of this elevated district.

In reviewing the characters of the series above described, the most noticeable feature is the almost total absence of red sediments, usually abundant where volcanic phenomena prevail, and here leading to the conviction that most, if not all, the beds alluded to, are not of eruptive but purely metamorphic origin. A few red beds, however, were observed a short distance back of Belleisle Corner, consisting of altered conglomerates associated with green epidotic rocks, and recalling the somewhat similar deposits already noticed near the mouth of the Nerepis, at the foot of the Long Reach. As these red and comparatively soft rocks are confined to the valley of the Saint John or its eastern prolongation, it is possible that the bed of the latter may once have been partly filled with such deposits, which have since been mostly removed by denudation.

There can be little doubt that the entire series of Belleisle rocks is to be grouped with those of the Kingston peninsula, which, indeed, they resemble even more strikingly than the deposits already noticed on the north side of the Reach. There is, however, one locality forming the western termination of the district referred to, in which the rocks differ so materially from anything seen in other portions of the ridge, as to require more particular notice.

Parish of Kars.—On the left bank of the Saint John River, and directly opposite the great granitic band of the Nerepis, occurs a series of bold bluffs confronting the shore, and comprising a variety of rocks for the most part very different from any which occur in this portion of the Province. They are well exposed in the neighbourhood of Tenant's Cove, and consist of the following kinds :—

a. Altered micaceous slate. Strike E. and W. Dip 80° N.
b. Porphyry and porphyritic slate.
c. Chloritic schist, greenish, with veins of epidote and asbestus.
d. Amygdaloidal slate.

e. Chloritic schist, with green oval spots of epidote. Strike N. 80° E. Dip 70° N.
f. Greenish altered grit, with veins of quartz and epidote.
g. Porphyritic diorite.
h. Porphyry, (base of compact felspar, crystals yellow and white.)

The above rocks occur in repeated alternations for a considerable distance. The porphyry alluded to is singularly beautiful, and is very similar to rocks of that variety as developed among the altered sediments of the Little River Group, hereafter to be described. Indeed, between the latter and the whole series above given, the resemblance is very striking. The abundance of epidote, the presence of asbestus, the chloritic schist with its oval spots, as well as the porphyry and porphyritic slate, are all features strongly characteristic of the "*Cordaite shales.*" One rock only, the porphyritic diorite, resembles the beds of Kingston and Belleisle.

From the singularity of the deposits, and the marked contrast which they exhibit to the beds of Bull Moose Hill and the adjacent district, I was led to make further examinations to determine, if possible, how far these beds extended easterly, and to settle the fact as to whether or not they constitute a portion of a separate group. For this purpose expeditions were made into various parts of the Parish of Kars, but no other outcrops similar to the above were anywhere observed. Along a line of section extending from Jenkin's Cove, in Belleisle Bay, to Rush Hill, in Queen's County, the only rocks noticed were altered slates and flags, bedded basalts, and diorites similar to those of Bull Moose Hill.

Age of the Kingston Group.—In the absence of fossils (none of which have yet been observed in beds of this group), we have only the general lithological characters and the stratigraphical relations upon which to rely for the determination of this important question. As the conclusions derived from these two independent sources accord exactly, we may consider the position of this formation as established with some degree of certainty.

a. Lithological Characters.—Some hesitation being felt by Mr. Matthew and myself in assigning definite names to the highly metamorphosed rocks of Kingston, Principal Dawson of Montreal, has kindly undertaken, in connection with Professor Hunt of the Canadian Survey, to examine a suite of the more characteristic specimens, and to compare them with the different rocks of Canada and Nova Scotia. The names assigned to the different beds in the foregoing descriptions are based upon the conclusions of these two gentlemen.

In remarking on the general appearance and composition of the specimens submitted to his notice, Professor Dawson observes: "In regard to the probable age of these rocks, Dr. Hunt does not regard them as very like anything he knows in Canada. They are not like the Quebec Group or the Laurentian, our two principal series of metamorphic rocks in Lower Canada.

"In comparing them with Nova Scotia, I have no hesitation in saying that they are *unlike* our Atlantic coast series, which I believe to be Lower Silurian, but that they are very like the rocks of the Cobequid Mountains

and of the inland hills of Eastern Nova Scotia, which I believe to be Middle and Upper Silurian. This is the age to which I would therefore be inclined to refer your rocks, though I would not affirm that they may not include Lower Devonian, which in Nova Scotia are altered with the Upper Silurian.

"I regard your specimens as altered sediments, though some of the felspathic and horneblendic ones may be true Plutonic Rocks."

b. Stratigraphical Relations.—While the specimens above referred to were in the hands of Dr. Dawson and Professor Hunt, Mr. Matthew, from an examination of the stratigraphical relations of the group, arrived at nearly the same conclusions. They are thus stated by that gentleman:—

"In Professor C. H. Hitchcock's First Report on the Geology of Maine, the rocks in the eastern part of Washington County in that State, are shown to be, to a great extent, of Upper Silurian age, organic remains of that period * having been found at Pembroke and Lubec. The slates of this district are penetrated and disturbed by large masses of trap rock, and contain deposits of copper as well as iron, while lead ores occur in the associated beds of limestone. This series of strata extends through the Islands of Passamaquoddy Bay to Saint George, where the ores of copper and lead occur in quantity in altered slates and limestone, associated in like manner with trap, and yielding fossils † (brachiopods, &c., not yet examined).

"The metamorphic strata at New River, further east, which appear to overlie these last, as will be shown hereafter, bear a strong resemblance to the Kingston rocks, and are on a line with them. Moreover, the anticlinal fold in the Pre-Silurian beds of Portland appears to be overturned to the north, and in such a case, if a fault exists along the line to the Kennebeckasis River, we would expect to find a younger group of strata on the north, opposite the older rocks of the south side of the river.

"In addition it may be observed that fragments of shale, holding fossil shells of Middle or Upper Silurian aspect, occur in the "drift" or boulder-clay at Saint John, pointing to the existence north of that place, of a group of sediments resembling those of Washington County, Me., and Antigonish, Nova Scotia.

"Their relations to other groups, as well as their appearance when altered, indicate that the Kingston rocks and their associates may be provisionally looked upon as Upper Silurian, though Middle Silurian and Lower Devonian beds may also occur. The only objection to this view is the absence of such hard rocks along the outcrops of the soft Lower Silurian strata in Saint John County, where these latter are covered by deposits of Upper Devonian age. This may be accounted for by denudation subsequent to their deposition, or by supposing an elevation of the older rocks above the sea when those of Kingston were being formed."

* Determined by Professors W. B. Rogers and E. Billings.

† First made known to me in the summer of 1864, by Mr. Frye, of Saint George.—L. W. B.

Topographical Features.—In the peninsula of Kingston the most striking topographical features are the remarkable parallelism of its sides, and the presence of longitudinal ranges of nearly uniform elevation, separated by series of parallel valleys. For over thirty miles its principal mountain chain is perfectly continuous in direction, stretching in picturesque cliffs from Hampton to the Milkish. Between this range and that bordering the southern shore of the Reach, (the latter being lower and less perfectly continuous than that of Clifton,) the land is nowhere high, a circumstance also indicated by the fact that the sub-carboniferous rocks begin to occupy this valley long before they reach the summits of its two bounding chains. To the eastward the whole series is depressed, and gradually dies away, while to the west the height progressively increases, the land growing bolder and higher, until at last it is abruptly terminated in the elevated ridges of the Land's End.

North of the Reach, the series of rocks doubtfully referred to the present group, is even higher and more rugged than those of Kingston. The Devil's Back, and other prominent ridges, are here included.

The westward extension of the Kingston series is so little known, that any attempt to describe its topographical features would be superfluous. The fact that it still remains for the most part in a state of unbroken wilderness, is a sufficient indication of its rough and sterile character.

In Charlotte County the area occupied by the rocks above noticed, and referred to the Kingston Group, is for the most part low; at least there is little variation in its features, and no high ridges appear. The greater portion of the route between Lepreau and Magaguadavic is through a country inconceivably barren, low bare ledges of rock, or extensive sphagnous swamps alone greeting the eye.

Agricultural Capabilities.—After what has been said, it will be readily perceived that that portion of the Province underlaid by rocks of the Kingston series is not adapted to the purposes of agriculture. The whole group is but scantily covered with soil,—extensive barrens and low sphagnous swamps, or bare elevated ridges, constituting its most common features. This is equally true of the rocks in the Kingston peninsula and of those in Charlotte. Although in each a few more fertile tracts occur, due to the action of existing rivers, or the distribution of the drift, the greater portion of the country occupied by these rocks is hopelessly barren.

Useful Minerals.—While proving thus barren for the purposes of agriculture, the rocks of the Kingston Group are somewhat more promising for the prospects of the miner. At several points they have been found to be metalliferous, and though the localities so far known are not numerous, nor the deposits extensive, it is to be hoped that they will not prove entirely without economical value.

The principal metalliferous locality in the present series is that situated at the foot of Dickie Mountain, near the Fingerboard, Norton. This spot, which was hastily examined in the summer of 1863, and alluded to in

my Report for that year, I have now studied with more care, and some additional facts of interest have been obtained which will be now described.

The following is the succession of rocks passed over in going from Norton Station to Blair's (now Coate's) Mill.

From the Station, along the line of the Belleisle Road, the rocks are sub-carboniferous conglomerates as far as the Mill, (a distance of one mile). In the ravine by the road-side, however, the older series appears a short distance below the Mill, and is as follows :—

1. Foot of Dickie Mountain.—Laminated compact felspathic rocks. Str. N. 62° E. Dip 80° N.W.
2. Dark felspathic quartzite, 100 feet thick.

At the Mill—3. Altered breccia? containing crystals of iron oxide in the flaws and crevices, associated with

4. Felspathic schist (consisting of a grey base with red felspathic blotches.)
5. Altered slates interstratified with the above. Str. N.E. & S.W. Dip 30° N.
6. Red cherty bands, containing crystallized oxide of iron. Str. N. 50° E. Dip 52° N.
7. Thick beds of gneissose mica schist. Strike and dip as before.
8. Dark sandy slate, gneissose mica schist, ferruginous felspar rocks, and altered sandstones.
9. (Separated from the last by 200 feet of soil.) Thick beds of grey bituminous limestone, holding argentiferous galena, and stained with carbonate of copper. The limestone (dipping easterly 40°) extends some distance to the westward, and holds the galena at a variety of places. It is evidently Sub-Carboniferous, and between Dickie Mountain and Belleisle Corner no rocks of earlier date appear.

The galena-bearing limestone may therefore be considered as situated at or near the base of the Carboniferous, and as the copper which it contains is a secondary product, we must look to the subjacent beds for the original deposit of the ore. In confirmation of this view I found that, lying between the limestone and the rocks above described, are a few outcrops (artificially exposed) of grey ash-coloured quartzite covered on its surface with thick scales of copper glance, the unaltered ore.

The locality is a more interesting one than I had first supposed, and is worthy of further practical exploration. As far as possible, I examined the rock in the vicinity with care, and also over the sides and summits of Dickie Mountain, but found nothing noteworthy additional to what has been stated above.

The relation of the beds of Norton, viz: First, the older series, (partly volcanic), then carboniferous limestone holding secondary ores, and lastly, carboniferous conglomerates, is remarkable, and will be again alluded to in the remarks on the metalliferous localities of Sussex, Quaco, and Shepody.

Besides the locality above described, no deposits of workable extent are known in the Kingston Rocks, either in those which form the peninsula of that name, or the similar beds northward and westward of the Reach, referred to the same series. A few simple minerals, among which may be mentioned chlorite, crystallized epidote, orthoclase, and specular iron, are found at many points, and are characteristic of the group. Iron pyrites is also abundant in several bands of micaceous slates at the Land's End.

In the remarks on the series constituting the high land northward of the Belleisle, reference has been made to the occurrence of two metals, Magnetic Iron at Bull Moose Hill, and Copper Pyrites along the ridge extending thence towards Butternut Ridge. These two localities require a more extended notice.

Iron Ore of Bull Moose Hill.—In the third Report of Dr. Gesner, (p. 51–2) a detailed account is given of the rocks occurring in the Parish of Springfield, and special reference is made to "an enormous deposit" of valuable iron ore, occurring on the farms of Messrs. Northrup and Benson, near Bull Moose Hill, and thence extending easterly and westerly for several miles. The same author moreover asserts his belief, that the bed referred to constitutes "one of the most extensive veins of iron ore in the British Provinces, being sufficient to supply America for thousands of years."

Having heard some doubts expressed as to the correctness of this assumption, I took pains to re-examine the district referred to, with the object of confirming, if possible, so important a discovery. After as diligent a search, however, as my opportunities permitted, I am compelled to say that the value of this ore, if such it can be called, has been greatly over-rated. It is true that many of the rocks contain a considerable percentage of oxide of iron, but nothing which could properly be described as an ore bed, was anywhere observed.

I have already alluded to this band of rocks, and stated that the latter are probably eruptive, though possibly of metamorphic origin. They comprise many varieties of diorite, some true granite, syenite, and hypersthenite. The rock which contains the ore is partly syenitic and partly dioritic, with perhaps some dolerite, while the ore itself is the magnetic oxide of iron. The latter, a very common associate of the last named mineral, is quite uniformly disseminated through the mass of the rock, and occasionally appears in crystalline grains. As far as examined, however, no true bed or vein was anywhere seen. The description of Dr. Gesner would imply that the ores are titaniferous.

While I am thus compelled to deny the richness of this iron ore, I am equally obliged to discredit the idea of its extended distribution. It is true that the dioritic range in which the iron occurs, extends for many miles to the eastward, but at no locality between Bull Moose Hill and Kierstead Mountain were any facts observed leading to the belief in the existence of beds of valuable ore.

Allusion has been made to the presence of copper in the slates accompanying the dioritic rocks above described. This fact was observed at two localities, not however, very remote from each other. The first is the farm of Michael Gallagher, about five miles west of Collina Corner, and near the Parish line between Springfield and Studholm. The rocks here consist of blueish and greenish micaceous slates, (Str. N. 40–50° E., dip about 50° southerly,) much folded and twisted. The greenish beds hold the copper, which is disseminated through the rock in small veins, comprising both the yellow sulphuret and peacock ore. The metal is not abundant, nor is there any distinct lode, but no explorations have been attempted.

The second locality is evidently continuous with the first, being composed of similar rocks, and similarly situated with reference to the dioritic band. It is on the southern slope of Kierstead Mountain, near the house of J. Chowan, Esquire. The quantity of the metal is even smaller than in that of the first described locality.

MICA SCHIST FORMATION.

The second of the series alluded to as geologically connected with the Silurian rocks, is the extensive formation long known for its valuable mineral deposits, to which the above name may be given, and which is found occupying extensive belts of country in the more central portions of the Province. Lying for the most part outside of the district which has occupied our attention, we propose to dwell but briefly on its characters, and only introduce it here as giving completeness to the geological succession in New Brunswick, and as helping to fill a wide hiatus which would otherwise exist, between the formations already noticed and those which are to follow.

Distribution.—The group of rocks to which the above name has been applied, occupies, in the centre of the Province, an area exceeded in extent only by the sandstones and shales of the Coal Measures. Entering the Province from the west in two bands, parallel to and resting upon the granitic rocks of York, they follow the latter in their northeasterly course completely across the Province. To the westward, moreover, the lower band seems to bend around, enclosing the Carboniferous formations, and to rest

along its southern limit on the granites of King's and Charlotte. It terminates abruptly at the Saint John River, in the southern part of the County of Queen's, where the beds are finely exposed in the village of Hampstead. The precise limits of their distribution are too little known to be described minutely.

CHARACTERS.—So far as my opportunities have admitted of their examination, the rocks of this series are remarkably constant in their character and composition. Although largely composed, as implied by the name above given, of micaceous schists, the group includes also extensive districts where argillaceous slates prevail, and, north of the coal basin especially, numerous beds of quartzite. The latter may be well studied at Prince William, above Fredericton, where they are particularly interesting from the valuable ores contained in them, and where also they afford the most satisfactory data upon which to base the question of their age. The quartzite beds in the district alluded to are frequently from four to five feet in thickness, and at the antimony mines form a portion of the walls of the lodes. The strata are usually nearly vertical, and have a general north-easterly strike, but with many sharp foldings; they are at times highly metamorphosed, and largely injected with quartz veins. I have succeeded in tracing beds similar to those of the antimony mines, as far as and beyond the Magundy settlement, while to the northward they rest against a wide belt of granite, being partly covered by rocks of the Coal Measures, which repose upon their upturned edges unconformably.

Between the rocks of Prince William and those of Hampstead, there is one important difference. While in the former quartzites are exceedingly abundant, so much so that over districts of considerable extent little slate can be found, at the latter the beds are almost wholly of the last named material, while the quartzite is nearly or quite absent. The slates of Hampstead are of two kinds. One is finely bedded, hard, and very micaceous, breaking into flat plates; the other is still harder, and very splintery, breaking with a pseudo-columnar fracture. The latter at first sight resembles trap, but in texture and composition is a true slate.

The general strike of the series at Hampstead is about east and west, the dip vertical and irregular. As the beds are conformable, or nearly so, the thickness of the entire series at this place cannot be less than 5,000 feet.

AGE.—The great antiquity of the series now under consideration was early recognised. In the Geological Report of Dr. Gesner, the term Cambrian is applied to this belt of rocks, and Dr. Robb in the construction of his map, based in part upon that Report, has adopted the same view of their age. This term *Cambrian*, though now usually discarded in American Geology, implies that the formation so designated occupies a position near or even below the base of the Silurian Series, having been originally applied to the rocks of Wales, and supposed by Murchison to be equivalent to the Huronian rocks of Canada.

To the adoption of the belief in a Pre-Silurian age for this extensive series of clay slates and mica schists, there are several strong objections. Of these the most important and conclusive is the marked resemblance already pointed out, both in character and position, between the Huronian rocks and the lower member of the Coldbrook Group. That the latter should be represented, within an area of eighty or ninety miles, by extensive deposits so unlike as the green volcanic beds near Saint John, and the compact grey slates of Queen's and York Counties, may well be regarded as impossible. We must, therefore, look to some of the vacant places of the geological scale as developed in New Brunswick, for the position which this series may be found to fill, and this position is most probably to be sought near the base of the Silurian Series, where a wide hiatus exists between the Potsdam rocks of Saint John and the Bloomsbury beds of the Upper Devonian. As already stated, this blank is partly filled by the rocks of Kingston, which, according to Dawson, are probably Middle and Upper Silurian, but a wide interval, representing the Lower division of that series (excepting the Potsdam rocks), would still be unaccounted for, and here we may provisionally place the series now in question. It may be further remarked in this connection, that the dissimilarity observed in the two great belts of York and Queen's Counties may really be indicative of their *different* age. The resemblance of the former to the slates and fine sandstones of Saint John is very marked, and it is possible that the two may be identical. The discovery of fossils in this series is therefore to be looked for with much interest.

Topographical Features and Agricultural Capabilities.—Although elevated considerably above the level of the great coal basin which they surround, the rocks of this series do not rise into any prominent ridges, and usually maintain a nearly uniform level. Being for the most part composed of hard materials, they do not readily yield to atmospheric agencies, and the soils where they occur are, with few exceptions, of a medium quality.

Useful Minerals.—Whatever may be the age of the mica schist formation, its economical importance as a metal-bearing series is yearly becoming more apparent. If, as there is little doubt, the two wide belts referred to this group, which cross the central portion of the Province on either side of the great granitic band of York, are really identical with the similar beds of Queen's, no other formation can compare with it either in extent or in the value of its mineral deposits. In these belts, as pointed out in my Report of 1868, occur the manganesian and auriferous rocks of Gloucester, the immense iron-ore deposits of Carleton, the antimony lodes of Prince William, and the ferruginous slates of Queen's.

These rocks, however, have not been included in the district to which our attention has been devoted, and we have therefore no new facts to offer. I may however state that within the last year operations have been continued at several of the localities above mentioned, and with very general promise of success. At the antimony mines, more particularly, work has been progressing vigorously, a new shaft having been opened and regular operations

entered upon. The quality of the ore now raised is of an excellent description. The following are the results of three analyses made by my brother, Mr. W. W. Bailey, on samples from the newly opened shaft:—

	1st Analysis.	Second.	Third.
Antimony,	68.98	70.1	69.00
Sulphur,	28.86	28.4	27.28
Iron,	.85	.0	.85
Gangue,	.81	1.5	1.50
	99.50	100.0	98.63

GENERAL REMARKS UPON THE AZOIC AND SILURIAN.

In the preceding descriptions of the formations severally referred to the Azoic and Silurian ages, we have confined ourselves to a simple and concise statement of the facts, without attempting to suggest any theories for their explanation. Before passing to the succeeding groups, of the Devonian, Carboniferous and Tertiary Ages, it is necessary to offer some few remarks on the probable origin of the rocks already described, their distribution, disturbances, and, in short, their general history.

A. Origin of the Beds.—In the Portland, Coldbrook, and Saint John Groups, (the formations here ascribed to the Silurian age, and partly perhaps to the Laurentian and Huronian,) we have presented to us rocks referable to three principal varieties of origin—aqueous, volcanic, and organic.

a. Fragmental Deposits.—Under this head are included all those formations, of purely aqueous origin, which owe their characters to the influence of moving waters, either the wave-action of a beach, the more powerful erosion of oceanic currents, or the slow and long continued attrition produced by the waves in sheltered bays, or at the bottom of deep seas. Under all these circumstances fragmental deposits are produced; coarse conglomerates and sandstones in the former case, shales and fine-grained slaty beds in the latter.

That a portion of the rocks of the Silurian and Azoic were of the character here described, can hardly be doubted by those familiar with the effects *now* produced by similar agencies on all our shores. The slates of the Portland Group, the sandstones and conglomerates which constitute the upper member of the Coldbrook, as well as the shales and sandstones of Saint John, are but the hardened beds of sand, mud or gravel which formed the bottom or shores of the sea in which they were deposited, and afford unmistakeable evidence of the physical conditions which prevailed in the ages to which they belong.

In the study of the rocks of the Portland Series, for reasons to be stated presently, it is very difficult to draw satisfactory conclusions as to their origin, or to give any adequate idea of the period which produced them. As already remarked, they are of extreme antiquity, and in the course of

subsequent ages have been so altered and disturbed, that few traces of their primitive character are now left to us. That the granites, syenites, gneiss, and mica slates, which constitute the great bulk of the formation, are really fragmental deposits, in other words, that they were once merely accumulations of pebbles, sand and gravel, is partly evidenced by the fact of their repeated alternations, which could only occur in deposits produced by shifting waters, and partly by the gradual transition from one of these beds into another, the former, perhaps, entirely destitute of any marks of stratification, yet passing into beds, which, except in their firmer texture, do not differ from the daily-forming deposits of our shores.

In passing from the highly altered sediments of the Portland Series to the consideration of the Coldbrook Group, which immediately succeeds, the recognition of the presence and mode of origin of its aqueous deposits is much less difficult. Yet even here, owing principally to the effects of volcanic action, the original character of the strata has been greatly altered. Passing over for the moment the consideration of its lower member, we have a succession of deposits, usually, though not invariably, of a somewhat coarse character, comprising rough sandstones, conglomerates, and grits. They are of great thickness, especially in the rear of Quaco, and are usually of a bright red or purple colour, the latter being the result, as observed by Mr. Matthew, of their association with volcanic outbursts. They may have been produced by the action of ocean currents, but it is more probable that they were due to the effects of the waves, beating powerfully upon an exposed coast.

Between the rocks above alluded to as constituting the upper member of the Coldbrook Group, and the deposits which underlie the City of Saint John, the contrast is very marked. While in the former, beds of coarse materials are almost universal, the Saint John Group is, without exception, a collection of the finer sediments. Throughout the limits of its distribution, not one conglomerate or even a grit has been yet observed; while the sandstones which occur interstratified with the slates, are usually of a fine and even texture.

In drawing our conclusions with regard to the origin of the rocks belonging to this group, we are no longer obliged to depend upon purely mineral characters. Evidence of a much more satisfactory nature is here afforded us, evidence which leaves no doubt as to the physical conditions under which these rocks were deposited.

Allusion has already been made to the presence in the Saint John slates of numerous markings, such as worm-burrows, shrinkage-cracks, ripple-marks, and the impressions of drops of rain. All these are faithfully recorded upon the rocks, and are the witnesses left upon the shore by the waves and sun, of the period which produced them. They teach us that that period, in this portion of the continent, was one of shallow waters, or slightly emerged sand-reefs, of coasts exposed to the alternate action of heat and moisture, coasts on which the impressions made by falling showers, or

the movements of marine animals, became hardened in the sun, to be afterwards filled and preserved by the further accumulations of sand and clay.

The evidence afforded by the markings alluded to, coincides with that derived from the organic contents of the beds. Trilobites, the most characteristic fossils, are believed to have inhabited shallow waters. Some of the finer deposits, as suggested by Mr. Matthew, may be of deep-water origin; but even these may have been the result of slow and long continued attrition, in shallow but sheltered bays.

b. Volcanic Accumulations.—These are confined to the lower member of the Coldbrook Group, and are evident in their mineral composition as well as in the alterations which they have produced on adjacent strata. It must not, however, be supposed that the whole vast accumulation of the deposits constituting that member are *purely* igneous in their origin. Though largely composed of matter ejected from volcanic vents, they also contain numerous beds of aqueous origin, and it would seem that the materials discharged by the former had, in most cases, been worked over, and re-assorted by currents of water.

In reflecting upon the enormous thickness and extent of the Coldbrook lavas, one naturally asks the question, From whence did all this material come? After the lapse of so many ages, the question is not an easy one to answer. Successive accumulations have buried and concealed the ancient surface, powerful water-currents have held sway over the entire district, volcanoes of a later age have again altered and disturbed the products formed at the earlier period. Probably many different vents existed; not mere craters like those of modern volcanoes, but extensive fissures, miles in length, whence issued the enormous floods of molten matter, or the showers of ashes, which now constitute the great bulk of the deposits.

We are indebted to Mr. Matthew for the recognition of one at least of these ancient volcanic openings. In his study of the rocks east and northeast of Saint John, that gentleman has recognized, near Dolan's Lake, at the source of the Coldbrook, a ridge of eruptive rocks, such as trap, basalt, hypersthenite, &c., extending for a distance of several miles, and probably indicating one of the principal vents or fissures from which the Coldbrook lavas flowed. In approaching this locality from its southern side, the gradually increasing quantity of volcanic beds, porphyritic and ashy slates, seem to point directly to this spot as their origin. This and other similar vents, now filled with eruptive matter, are indicated upon the map by a bright crimson colour.

c. Beds of Organic Origin.—Under this head are usually included limestones, either with or without fossils, and coal, the former being the result of animal activity, the latter of vegetable accumulation.

The great abundance of limestone beds in the Portland Group has already been pointed out, as well as the fact that they are destitute of fossils. We have then only the general character and association of the beds on which

to base our judgment of their mode of origin. Mr. Matthew has pointed out the abundance of magnesian silicates which they contain, and in suggesting the idea that they are partly dolomitic, believes that they may have been produced by chemical deposition; the entire absence of fossils, notwithstanding the partial metamorphism of the beds, seeming to disprove the theory of organic secretion.

It is, however, to be observed, as remarked by Professor Dana of other portions of the continent, that conditions favourable for the production of precipitated limestones on so vast a scale are not likely to have occurred, while the mere absence of fossils does not necessarily disprove their animal origin, for "the sea which grinds pebbles and sand and makes fine sandstones, may also grind shells and make an impalpable limestone." The same author also suggests that some of the more ancient limestones of America may have been produced by the accumulating shells of minute animals, termed Rhizopods, all traces of which would be destroyed by a slight degree of metamorphism. Such may have been the origin of the Portland Limestones.

The presence of graphitic laminae and thick beds of graphite, interstratified with these limestones, indicates, so far as such remains can do, an origin near the level of the sea. It would seem that the theory of wave action on a coast, where calcareous beds were forming, but where also plant remains might occasionally be deposited, offers the most satisfactory explanation of this difficult problem.

B. Metamorphism.—By this term is meant that alteration in aqueous deposits, characteristic of all the more ancient rocks, by which they have lost their original nature, become hardened and solidified, or as in extreme cases, completely re-formed and crystallized.

In the rocks of the Portland Group, especially in those which constitute its lowest beds, this process of alteration has reached its utmost limit. The granites, syenites, &c., which form the greater portion of its bulk, are crystalline rocks, and though probably once like the beds of sandstone, slate and shale of later periods, have now lost all trace of their sedimentary origin, and can with difficulty be distinguished from those which are purely igneous. That the great majority of these granites and syenites are really metamorphic, however, cannot be doubted, as they may readily be traced merging into those of a stratified character, such as gneiss and mica slate.

In the upper beds of the Portland Group, as pointed out by Dr. Dawson and Mr. Matthew, the metamorphism is less extreme. Vegetable accumulations have, however, been changed to graphite, the limestones have lost their colour, and the organic contents of both have been for the most part obliterated. All these changes may have taken place without the existence of distinct volcanoes.

In the Coldbrook Group, metamorphism is still a common feature, especially in the Lower Member, but here it is most apparent in the effects of

volcanic action. There has been, as observed by Mr. Matthew, a *local* metamorphism, whereby the stratification of that member has been almost obliterated.

In the Saint John Group, though the slates and sandstones of which it is composed have been hardened and compacted, the changes here alluded to have been much less prominent. There has been only a *partial* alteration of the beds, most marked near the western limit of the group, and growing gradually less evident as the latter is traced to the eastward. Besides the mere consolidation of the beds, whereby soft shales have been converted into compact semi-crystalline slates, this partial metamorphism is shown in the effects produced upon the fossils of the group. The Trilobites and Brachiopods were probably as abundant in the neighbourhood of Saint John as elsewhere, yet here they are so excessively distorted as to be incapable of recognition. Farther to the east, at Ratcliffe's Stream, they both are abundant and almost as perfect as when originally buried.

C. Disturbances and Foldings.—To those familiar with the action of river and oceanic currents in forming sedimentary beds, the mere statement of the fact that the series now under discussion are composed of stratified deposits, will be sufficient evidence that these deposits once occupied a horizontal position. That they have now lost this original horizontality is equally apparent to those familar with the general character of the groups, a fact which is nowhere better displayed than in the slates and sandstones of Saint John, these latter having been violently folded and twisted in every conceivable direction. The same is equally true, though less directly apparent, in the altered rocks of the Portland and Coldbrook Groups.

How far the foldings and displacements which characterize these formations, are the results of disturbances confined to the Azoic and Silurian Ages, or how far they may belong to succeeding epochs, it is very difficult if not impossible to say. That most of them were produced at a much later period is conclusively proved by the fact, that the newer as well as the more ancient beds have been involved in the change referred to, a general parallelism in the direction and inclination of the folds being apparent from the bottom of the Coldbrook Group to the upper member of the Devonian. The upheavals and mountain-making which marked the close of the latter age will best be understood after a more minute description of its several formations. Between the deposits of the Coldbrook Group, however, and the underlying beds, Mr. Matthew has observed evidence of slight unconformability.

That the Portland rocks had undergone some degree of flexion, independently of the disturbances shared by them with the Silurian and Devonian Groups, seems probable from the succession of similar deposits in various portions of the mass. Mr. Matthew has thus recognized one synclinal fold at least, distinct from the great upheaval in which the rocks of this series were affected along with the deposits of later ages, and it is not unlikely

[illegible]. One great [illegible] of a similar character is [illegible] Kingdom, [illegible] these, as in the Portland [illegible] alternations of level, from the extreme [illegible] of the lands.

[illegible] The organic remains which the rocks of the Portland and Saint John Groups contain, are entirely of marine origin. Of the former too little is known to draw satisfactory conclusions as to the life of the period, even if such life existed in its earlier beds. In the upper portion of the series, the occurrence of graphite, as well as of obscure plant-remains, indicates the existence of a vegetable, as do possibly the limestones that of an animal, world, but both were probably confined to the ocean, the former consisting only of the lowest Algae, or Sea Weeds, the latter of the humblest Mollusks and Radiates, or even of the lower and systemless Protozoa.

The Coldbrook Epoch has furnished no traces of the organic world. If such ever existed in the beds, they have been destroyed, and all traces of them removed, through the influence of intense volcanic action.

The Saint John Group, on the contrary, affords many and interesting evidences of the peculiar Flora and Fauna of the age. Trilobites among Crustaceans, Brachiopods among the lower Mollusks, and worms, seem to have been the characteristic animal life of the period. They are all *marine*, and therefore indicate that the sea had partial sway over the regions where they were found. The vegetable fossils, though poorly preserved, also [illegible] a similar origin.

[illegible] OF THE CONTINENT DURING AND AT THE CLOSE OF THE AZOIC AND SILURIAN AGES.

[illegible]

[illegible]

degree of certainty upon the conditions of the periods in which they were produced. That the date of their displacement and upheaval was long subsequent to that of their deposition, there can be little doubt, and it is highly probable that they, like the Saint John and Coldbrook beds, were formed during a period of general quiescence. That they should be unrepresented south of the Portland anticlinal, where a wide hiatus exists between the Potsdam or Primordial and the Upper Devonian Groups, may be due to the fact that this portion of the Province was then above the level of the sea, or else that the beds here formed were removed by denudation. The latter is probably the true explanation, as is evidenced by the fact that the character of the Saint John Group implies a subsidence of the land when its upper beds were formed.

In fine, we may consider the Silurian Age as marked in New Brunswick by a succession of minor oscillations, slight changes of level, producing alternations of different stratified deposits, but with no disturbances or upheavals of great magnitude. In many of these features it stands in marked contrast to those which immediately succeed.

BLOOMSBURY GROUP.

The Bloomsbury Group, like the Coldbrook which it closely resembles, comprises two very different series of sediments, the lower and older being volcanic, while the upper and newer is of aqueous origin. These must be separately considered.

A. Volcanic Beds.—Distribution.—The most extensive and typical exposure of the volcanic beds of the present group is furnished by the locality from which their name has been derived, the high hill called Bloomsbury Mountain, near the centre of the Parish of Simonds. This mountain, as described by Mr. Matthew, constitutes the western termination of a ridge of land extending northeasterly in the centre of the County, and appears to represent one of the ancient fissures or volcanic vents, from which, during the Devonian period, were poured forth the lava, ashes, and scoria, which now constitute the lower member of the Bloomsbury Group. The streams of eruptive matter, thus discharged, flowed from the central opening in three directions, northeasterly, westerly, and southwesterly, as indicated by the positions which they now occupy.

The upper limit of the Bloomsbury lava streams, trending to the west, may be traced in a long, though narrow, line of hills, from the head of Black River, below Loch Lomond, to Courtnay Bay. Removed by denudation from the latter, the beds of the group re-appear in the southern part of the City of Saint John, and again on the opposite side of the Harbour in the Town of Carleton. They are somewhat increased in bulk in the latter place, but soon disappear to the westward under extensive accumulations of post-pliocene gravels. At Sheldon's Point, however, and Manawagonish,

rocks probably referable to the present group occur, and beyond in the peninsula of Pisarinco, as well as on the Musquash River, and westward towards Lepreau.

The second great belt of Bloomsbury lavas, trending southwesterly, though in much thicker beds than those last described, is comparatively limited in distribution, reaching only from the central vent of Bloomsbury Mountain to the Millicent Lake, in the rear of Mispeck. The valley of Black River cuts directly across, and is largely included in the series referred to, and in its upper part forms the line of division between its two members. The thickness of the lower member, as measured by Mr. Matthew, has been approximately stated at 2000 feet.

Of the eastward flow of the Bloomsbury lavas, little is known. Notwithstanding the great thickness of the group near the sources of Black River, it can be traced but a short distance in this direction, being rapidly covered and concealed by the carboniferous deposits in the rear of Quaco.

CHARACTERS.—At Bloomsbury Mountain, where the best exposure has been stated to occur, the following peculiarities have been noticed by Mr. Matthew:—

"The elevation consists of basaltic trap, and is flanked on each side by beds of amygdaloid, trap-ash, and other products of volcanic origin, which also cover the crest of the anticlinal fold for two or three miles west of the hill. The succession of strata is best displayed on the south side of the hill, where they succeed each other in the following order:—Basaltic trap, unstratified, of great thickness; bedded basalt, amygdaloidal porphyry, bedded basalt, hornblendic trap-ash, micaceous quartzite, vesicular trap-ash slate; thickness of the stratified deposits about 3,000 feet. There is also on this slope a volcanic conglomerate, viz., fragments of trap rocks imbedded in trap-ash slate. The quartzite resembles some of the finer beds at West Beach and Black River, and the porphyry is that alluded to in Gesner's third Report, p. 15. The trap-ash slate is in many places full of irregular vesicles, the sides of which are coated with minute crystals of quartz, calcite, and specular iron."

The remaining portions of the Lower Bloomsbury beds do not differ from those above described, except in the comparative infrequency of unstratified basalt.

B. SEDIMENTARY BEDS.—DISTRIBUTION.—The deposits of the Upper Bloomsbury, of purely aqueous origin, are generally found in bands of varying width, lying parallel to, and immediately above the volcanic deposits of the lower member. They may thus be traced, following the different distribution of the latter, almost throughout its entire extent. The greatest development of the member is along the space between the Black and Mispeck Rivers, and towards the foot of Loch Lomond. On the southern shore of the latter red sediments also occur, which have been doubtfully referred to the Coldbrook Group, but may possibly be a continuation of the beds

last described. On the south-eastern side of the Bloomsbury axis, the upper member of the group again appears, but it is here a comparatively thin deposit, and occupies but a very limited area.

Turning to the westward, this member is also but poorly represented, and at Courtnay Bay does not exceed a thickness of 150 feet. In Saint John and Carleton, as well as at Sheldon's Point, it is wanting altogether. On the west branch of the Musquash, however, in the village of Ivanhoe, reddish sediments occur, resting upon the Portland series and overlaid by the Dadoxylon sandstone, and therefore belonging to the Upper Bloomsbury, but whether they have any direct connection with the deposits to the east, or are the result of some nearer and independent outburst, it is at present impossible to say.

CHARACTERS.—In lithological characters the upper member of the Bloomsbury Group is very constant, consisting of fine-grained red clay slate and reddish-grey conglomerate. Its thickness has been stated at 500 feet. The rocks of this member, according to Mr. Matthew, constitute a passage from the volcanic beds to the sandstone of the (Little River) group above. As far as known they contain no fossils.

AGE.—The association of the Bloomsbury rocks with the Groups which are to follow, is conclusively proved by the general similarity of their deposits, by their entire conformability, and by the *absence* of such perfect conformability between these and the Primordial (or Saint John) rocks below. As the overlying beds have been shown to be unquestionably of Upper Devonian age, there can be no hesitation in referring the Bloomsbury Group to the same horizon.

Although occupying a large area in Southern New Brunswick, and attaining a great thickness, this group may be a comparatively local one, not directly representing any of the sub-divisions usually adopted in the description of other portions of the Continent.

TOPOGRAPHICAL FEATURES.—Although comparatively limited in their distribution, the two members of the Bloomsbury Group, when present, occupy a prominent topographical position, and confer a very marked character on the scenery and physical features of the districts where they occur. The volcanic member, especially, rises prominently above the general level of the country, and has, more perhaps than any other series, been concerned in the peculiar configuration of the district east and southeast of Saint John.

Reference has already been made to the westward flow of the Bloomsbury lavas, and their separation into two belts near the foot of Loch Lomond, one turning westerly to the Harbour of Saint John, the other in a more southerly direction, towards the mouth of the Mispeck. These two belts, now rising into hills of moderate elevation, are really connected through their whole extent, but from the effects of folding and denudation after they had been covered with later deposits, now present the appearance of two diverging ridges, enclosing a valley of triangular shape, narrow at its apex

near the Bloomsbury vent, and widening outward and westward towards the sea. Over the area now occupied by this valley, which, however, had not then been formed, were deposited, during the succeeding Devonian epochs, the sedimentary beds which now constitute the Little River and Mispeck Groups.

AGRICULTURAL CAPABILITIES.—Being of limited and comparatively local distribution, I have had no opportunity of personally examining the fertility of the land underlaid by the Bloomsbury Rocks. Mr. Matthew, however, to whom the group is familiar, describes the district which they occupy as bold, but in general clothed "with a generous forest growth."

USEFUL MINERALS.—So far as known, the Bloomsbury Group is destitute of metallic ores, or other minerals of economic importance.

LITTLE RIVER GROUP.

In the remarks on the topography of the Bloomsbury Group, it was stated that the two diverging lines of volcanic hills, which represent the course and position of the Bloomsbury lavas, are the bounding ridges of a valley, in which now lie the later beds of the Devonian. The first of the series thus included, resting on and conformable with the underlying beds, is that to which the above name has been applied.

The Little River Group consists of two members, one of coarse and the other of comparatively fine ingredients, termed, from the characteristic fossils which they hold, the Dadoxylon Sandstone and the Cordaite Shales. Though intimately connected, they do not invariably occur together, and for this reason as well as others, will be separately considered.

A.—DADOXYLON SANDSTONE.

DISTRIBUTION.—The lower member of the Little River Group, to which the preceding name has been applied, immediately succeeds and rests upon the upper member of the Bloomsbury. Folded with the latter into a depression or trough, it has been traced by Mr. Matthew in a double curve extending from Manawagonish, west of the Harbour of Saint John, around, and along the southern flank of, Bloomsbury axis, maintaining throughout this district a nearly uniform width.

On the eastern side of Courtnay Bay, it first appears near the mouth of Little River, and thence following the line of the Bloomsbury beds below it, extends northerly and easterly towards the head of the Mispeck, being very well exposed at Mount Prospect, about four miles east of the City. Near the sources of the Mispeck the band of these rocks bends slowly around, assumes a southerly direction, and follows the last named stream to within a few miles of its mouth. Again changing its direction, it now flanks the end of the Bloomsbury ridge, and extends in a narrow belt eastwardly as far as the east branch of the Black River. Beyond the latter, as far as known, it rapidly disappears.

To the west of Saint John, besides the locality at Manawagonish, the Dadoxylon Sandstones have been observed by Mr. Matthew and myself on the west branch of the Musquash River, in the village of Ivanhoe, resting upon a deposit of the Upper Bloomsbury and overlaid by Cordaite Shales.

CHARACTERS.—It has already been remarked, when describing the characters of the Bloomsbury Group, that the red deposits, which form its upper member, constitute beds of transition between that group and the one now under consideration.

As indicated by the name it bears, the Dadoxylon Sandstone is chiefly composed of coarse materials, though less so than in the group which immediately preceded it. While the upper beds of the latter consisted chiefly of reddish conglomerates, the present series is composed of a hard grey sandstone, associated, however, with occasional beds of grit and layers of dark grey shale. The transition above alluded to consists, therefore, in a gradually increasing fineness in the sedimentary beds, indicating changes in the physical conditions under which they were deposited.

In lithological characters, the Dadoxylon Sandstone, as described by Mr. Matthew, is remarkably uniform and constant, and has been of great service in the study of the geology of the section now under consideration. But the chief interest which attaches to this deposit, is derived from the abundance and wonderful perfection of the organic relics which it holds, the first undoubted relics of a land vegetation in the long series of formations which have so far occupied our study. A detailed account of these plant remains, and of the localities in which they occur, will be found in a later portion of this Report.

B.—CORDAITE SHALES.

In the consideration of this, the upper member of the Little River Group, we have presented for our study by far the most useful and interesting deposit which occurs in this portion of New Brunswick, if not indeed in the whole Province. Recognizing its economical importance as a rich metalliferous series, it has been one of the special objects of the present survey to ascertain minutely the distribution, age and characters of the rocks composing it, and to mark its limits accurately as the great copper-bearing group of Lower New Brunswick. Although the greater portion of the country occupied by this series is still uncleared, and among the wildest and most rugged in the Province, we have so far succeeded in tracing out its rock formations, that the limits of the latter may now be looked upon as approximately fixed, at the same time that its age and productive metalliferous character are satisfactorily established. As the details of this examination are of great importance, I shall here describe the observations made more minutely than in the case of the preceding groups has been deemed necessary.

DISTRIBUTION.—It will naturally be supposed that, forming as they do two members of a single group, the Dadoxylon Sandstone and Cordaite

Shales should be intimately associated and occur together, and that the distribution of the former should be a general indication of the position of the latter. While, however, this is true as regards that portion of the group occurring in the neighbourhood of Saint John, it has been ascertained that the Dadoxylon sandstones constitute a comparatively local deposit, while the shales which succeed, spread much more widely over extensive districts, both to the east and west.

On the eastern side of the Harbour of Saint John, the shales referred to are first met along the coast near the mouth of the Little River, where they form a narrow band lying between the embouchure of that stream and the promontory of Red Head. The band of rocks thus appearing, though narrow at the coast, widens as it is traced into the interior of the peninsula, and follows approximately the curve already pointed out as marking the distribution of the subjacent sandstone. The line of its outcrop may be readily traced on the geological map, forming a sharp and somewhat irregular curve, extending from Red Head to the Mouth of the Mispeck. In the latter portion of the curve, owing principally to a fold in the strata, the rocks occupy a somewhat wider space than is covered in the former.

Terminating on the coast at the locality last mentioned, the Cordaite Shales, now trending southwesterly, seem for the moment to be lost in the waters of the Bay. Like the sandstones which underlie them, however, they follow the curve of the volcanic beds of the Bloomsbury Group, and doubling the promontory which marks the southwestern termination of the latter, reappear along its eastern flank, still resting upon the Dadoxylon Sandstone, and extend in this direction to the mouth of Emerson's Creek. Along this portion of their distribution, however, between the Mispeck and Black Rivers, there is a great difference in the character of the group observable, so great a difference, indeed, as to have caused some hesitation in assigning these beds to their true position. They occupy the coast from the point southwest of the Millicent Lake, including Beveridge and Thomson's Coves, as far as the mouth of the Black River. On the eastern side of the latter they extend along the shore to Emerson's Creek, and in the interior to a somewhat greater distance, but from this point are rapidly covered with the carboniferous deposits which extend to Quaco. They reappear, however, northwest of the last named place, and eastward of Tynemouth or Ten Mile Creek, where they rise into a low ridge, consisting chiefly of the conglomerates at the base of the series, and are crossed by all the principal roads leading in this direction.

The same series has also been observed on Vaughan's and Macomber's Brooks, northeast of Quaco, covered as before by carboniferous deposits on its southern slope, and to a less degree on its northern also, where, however, it is succeeded, at a very short distance, by beds of the Lower Coldbrook. Owing to the disturbances and foldings alluded to in the description of the latter, the whole vast mass of the Lower and Upper Bloomsbury, Saint John Slates, and Dadoxylon Sandstones, have mostly disappeared, and we here

find beds even below the base of the Silurian almost side by side with the shales of the Upper Devonian.

From Vaughan's Brook, in the neighbourhood of Quaco, the Upper Member of the group now under consideration begins rapidly to widen, and to the eastward soon attains an enormous development. Higher members than those last described appear at Melvin's Beach, and thence, with the exception of a few isolated carboniferous deposits at Salmon River, Goose Creek, and Martin's Head, extend with a bold and unbroken front along the coast to Point Wolf, at the western limit of Albert County. They thence no longer keep the shore, but, pursuing their normal course, may be traced in a series of bold high ridges as far as Shepody Mountain.

While the southern limit of the group is thus uniform and regular, the line which marks its northern boundary is more difficult of recognition. Owing to one or more immense synclinal folds, the area covered by these rocks is enormously increased, and from the limited space occupied near the sea coast, behind Quaco, now widens until it embraces the whole extent of country south of the Shepody Road. On the latter thoroughfare the rocks of the group were first observed near Wallace's Post Office, in the Parish of Hammond, King's, and near the source of the Great and Little Salmon Rivers. On the last named stream they were found to occupy the whole country southward to the coast. Whether they similarly occupy the entire valley of the former has not been ascertained, the difficulties of descending these rapid and mountainous water-courses, through a country without a settlement, being of too difficult a character to admit of exploring both of the above named streams. The limits of the group in this direction, however, cannot vary far from the outlines as laid down upon the Map.

Following the line of the Shepody Road from the point above mentioned, the rocks of the present group, or "coast series" as it may conveniently be termed, have been distinctly traced to the eastward as far as the high lands back of Hopewell, while deposits, probably referable to the same series, have been observed at a great variety of places both in the County of King's and eastward in that of Albert. These will be severally referred to in the remarks on the characters of the group.

In general, it may be stated that the upper limit of the series is a line extending nearly northerly from the vicinity of Quaco, crossing the Shepody Road near the sources of the Salmon River, thence extending in the same line so as to include a large area in the Parish of Hammond, to near the sources of the Pollet River. It follows the line of the Shepody Road eastward into Albert, and certainly includes all that portion of the latter country which lies southward of that road, between it and the sea; while the character of the metamorphic series which appear to the northward, would seem to indicate even a wider distribution. Like all the older formations in this portion of the Province, the Little River Group is progressively covered to the eastward with carboniferous deposits, which at Shepody Mountain finally cap the subjacent metamorphic beds, and form their well-marked eastern termination.

Before the commencement of the present season's work, our knowledge of the extent of this most important group was limited to the area immediately about Saint John, and eastward to Black River and Gardner's Creek. We have now succeeded in fixing its true limits in this direction, and in giving to it a distribution which, to say the least, is as gratifying as it was unexpected.

But not only have these metalliferous rocks been thus found to occupy such an extensive area to the east; they have also been found to spread widely to the west, and to give promise of valuable discoveries in a region to which, as yet, but little attention has been paid. I refer to portions of the peninsula of Pisarinco, west of Saint John, and to a large district south of the Musquash River, between the Lancaster Mills and Chance Harbour. Their distribution in this direction will be best understood after a description of the characters of the group shall have been given.

CHARACTERS.—In passing from the Lower to the Upper Member of the Little River Group, the transition which we have already pointed out as marking the change from the Upper Bloomsbury beds to the Dadoxylon Sandstone, attains its maximum, the Cordaite Shales, as their name indicates, being chiefly an accumulation of the finer sediments. Such changes from coarse conglomerates to sandstones, and from sandstones to shales or limestones, are of constant occurrence in geological history, and are of the highest importance, indicating as they necessarily do, great physical or geographical changes in the circumstances under which the formations were deposited.

In the group before us the transition from coarse to finer sediments is very gradual, and even in the member we are now considering, though fine slates and shales constitute its most common feature, many of the latter are rough in texture, and there are frequent alternations of coarser beds. Sandstones, quartzites and grits are not of unfrequent occurrence, and in some localities, especially where the upper layers are found, conglomerates appear. As there is much variety in this respect, and as the area covered by this group of rocks is a very large one, it will be necessary to describe the peculiarities of each locality separately.

a. From Little River to Mispeck.—In this portion of the series, the position of which has been already traced, we find the most characteristic and typical exposures of the beds, or at least those which best display the peculiarities of structure and composition, upon which are based the name and associations of the group. At the locality north of Mount Prospect, where the series was originally studied by Mr. Matthew, all the above varieties of rocks occur, viz: grey, greenish and red shales; reddish and grey sandstones, grits, and conglomerates alternating with the shales. In two thirds of the thickness of the latter that gentleman has observed as many as thirty seven distinct alternations with the coarser beds, varying from two to forty feet in thickness, and indicating, as above explained, an equal number of changes

in the direction, force, or depth, of oceanic currents. In the upper third, according to the same authority, the sandstones become redder, and some thick beds of a coarser conglomerate appear.

Near the upper limit of the group, a tendency is again apparent to accumulate deposits of the coarser kinds, the beds thus characterized forming beds of transition to the lower sediments of the Mispeck Group.

From Mispeck to Emerson's Creek.—Allusion has already been made to the occurrence between the above-named localities of a series of highly altered rocks, so different in their composition and characters from those of any other series in this portion of the Province, that much doubt has existed with regard to their true relationships.

The rocks in question, stretching along the coast for a distance of several miles, from Cape Spencer to beyond the embouchure of Black River, consist of a thick series of micaceous slates, imperfectly formed granites, or semi-granitic sandstones, with some volcanic beds, conglomerates, grits and limestones. At Beveridge Cove and West Beach, Mr. Matthew has observed the following succession:—

1st. Red clay slate, and grit, and coarse reddish micaceous slate, resting upon the Dadoxylon Sandstone.

2nd. A thick mass of granulite, and imperfectly formed granite, with beds of trap-ash.

3rd. Grey micaceous slate.

4th. Reddish sandstone and grit, overlaid by coarse conglomerate, holding beds of *haematite.*

5th. Dark grey micaceous slate, and basalt, (stratified ?).

A short distance to the eastward, the quasi-granite passes into schist, abounding with volcanic ash beds, and overlaid by similar strata containing several large beds of iron ore. Further east in the same metamorphic series are a number of thick belts of impure limestone much altered, and hard clay slate with copper pyrites.

The limestones may be seen near the entrance to the settlement of Black River, on the Mountain Road from Loch Lomond, and, as described by Mr. Matthew, appear to be on the line of a minor synclinal fold. They are covered by shaly beds, holding imperfect remains of plants (the only plant remains found in this series east of Cape Spencer,) and are tinged of a green colour by the decomposition of the copper pyrites which they hold. Above the shaly beds are heavy accumulations of granitoid sandstones, like those above alluded to in the sectional list, associated with argillo-micaceous slates. The latter would appear to be, with the exception of some traps, the highest beds developed at this locality.

From Emerson's Creek to the region behind Quaco, the Cordaite Shales are chiefly represented by a long low ridge, consisting of heavy beds of red conglomerate and dark red slate, and are continuous with the first member of the series as found at Beveridge Cove. In the western part of the Black

River settlement, they have been observed by Mr. Matthew resting conformably on the Dadoxylon Sandstone, and therefore representing the base of the series. They thence continue to the eastward, but as noticed in the remarks on their distribution, are mostly, if not entirely, covered and obscured by carboniferous deposits. They may be seen on the old road to Quaco, about four miles from that village, and consist of red metamorphic slaty conglomerates.

On Vaughan's and Macomber's Brooks, four miles northeast of Quaco, the same series again appears, still at the base of the Cordaite Shales, and consists of the following rocks, in descending order;

1. Grey conglomerates with angular pebbles.
2. Reddish conglomerate with red slate pebbles, (also red slate?)
3. Pale reddish grey sandstone.
4. Conglomerate, like No. 2.
5. Slaty grit, (dark reddish brown.)

The section is terminated, between four and five miles out, by volcanic rocks of the Lower Coldbrook Group.

Eastern portion of Saint John County, including the Coast and the Little Salmon River.—Although not developed in the immediate neighbourhood of Quaco, the Cordaite Shales begin, from the locality last described, to widen in the limits of their distribution, and soon attain an enormous development, including, as before stated, the whole district along the coast and south of the Shepody Road, far into the County of Albert.

The series first strikes the Bay about seven miles east of Quaco, in high bold ridges, at Melvin's Beach. It here consists of micaceous slates, but exhibits no features of especial interest. Between Melvin's Beach and the mouth of Little Salmon River, no examination has been made, unfavourable weather preventing the carrying out of our designs in this direction. From the observations made on the last stream, however, and along the coast to Point Wolf, it may with much probability be inferred that no essential differences of structure will be here displayed. The observations referred to will now be given.

Little Salmon River.—From the position and course of this stream, taking its origin in the lower part of the Parish of Hammond, (K. C.), and thence running almost due southerly to the coast, it was hoped that its examination would be attended with very important results, and that the entire series of rocks, from the base to the summit of the group, might be passed over in their true succession. It will however be seen that these expectations, owing to a folding of the strata along the course of the river, have been but partly realized.

After reaching the head-waters of the Little Salmon River, where the latter is crossed by the Shepody Road, a division of our party was made, Mr. Matthew undertaking the arduous task of descending the stream above named, while Mr. Hartt and myself examined the district northward to the Parish

of Sussex, and thence eastward along the Shepody Road into the County of Albert.

As descriptive not only of the geology, but also of the topographical features and general aspect of the country occupied by this band of rocks, I here add Mr. Matthew's observations, as graphically given in his own words.

Crossing from Wallace's Post Office on the Shepody Road, three miles over level and undulating land, the river was reached at a bridge, about eight miles above its mouth. "Below the bridge, for the first two miles, the valley is narrow, and shut in by lofty and steep hills from 150 to 200 feet high. The rocks which appear along the sides of the stream are chiefly schistose, becoming coarser in texture as the Upper Falls are approached. At the bridge, and for a mile below it, the bed of the stream is filled with shingle and boulders, though ledges of slate of pale buff, grey, reddish, purplish and greenish colours, appear at intervals, (apparently talcose, though in reality micaceous.)

Near the Falls, beds of greenstone may be seen interstratified with blueish and grey slaty micaceous grits. At this point, the depression through which the river runs is no longer a valley, but becomes a narrow gorge or ravine shut in by precipitous hills, increasing in elevation as the coast is approached, from 250 to 400 feet high. One elevation opposite Carleton's Mill is said to rise to the height of 500 feet.

For six miles the bottom of the gorge is very rough, and the stream is broken by frequent falls, rapids, and eddies. So tortuous does it become, that in many places the bed of the stream and the course of the valley cannot be seen for a distance of more than from two hundred to four hundred feet. At a mile from its mouth, the latter, although still narrow, enlarges and terminates abruptly at the shore of the Bay, between high hills.

For two miles from the Upper Falls, passing the Little Falls, and as far down as the Lower Falls, little else is met than a grey clay slate, frequently tinted with green and blue, and somewhat indurated. For three miles below the Falls, passing the points known as "The Long Eddy" and "Keyhole," the only rocks seen were thick homogeneous beds of cherty or jaspery slate, (variegated with red, purple and grey colours, and sometimes beautifully striped with various shades), except for a short distance, where the stream crossed beds of purplish and greenish slate, holding shining films of chlorite.

Half a mile from the Mill the grey clay slates noticed above, were again met with, and from the Mill to the Bay shore we re-crossed the micaceous slates, grits and conglomerates observed on the upper part of the stream. On the shore, eastward of the entrance, my attention was called to a small quantity of copper ore (associated with much iron pyrites) occurring in the slates at that point, but no regular vein was seen."

From the Head of Little Salmon River to the boundary of Albert County.—While the examination of the district intersected by the Little Salmon

River was being undertaken, as above described, by Mr. Matthew, observations of a similar character were made by Mr. Hartt and myself on the country lying to the north and northeast of the same stream.

Allusion has previously been made in the remarks on the Coldbrook Group, to a band of volcanic rocks, crossing the Parish line between Sussex and Hammond, and near the Manganese mine of Mr. Davidson. Pursuing a southerly course from that locality, the first rocks of a different character are seen near where the Crow Brook, a branch of the Great Salmon River, crosses the Shepody Road. They consist of pink granites, or semi-granitic altered sandstones, probably not eruptive. From Crow Brook to Sand's Lake, near the Shepody Post Office, the rocks are micaceous slates, pyritiferous gneissoid slate, and slaty grit.

To the eastward of the Shepody Post Office, for a distance of one mile, and thence northward to the vicinity of Pleasant Lake, no marked difference is apparent, until the latter is approached. The first rocks seen are granitic, much like those near Crow Brook, but are here partly gneissoid, and distinctly interstratified with slaty beds. The latter are almost talcose, and much contorted, having, however, a general strike of N. 60° E., and a northerly dip of 45°. The alternation of these two kinds of rocks continues for a distance of several miles.

Turning north along the eastern branch of the Little Salmon River, the same series continues, without, however, the granite beds, to a point about a mile west of the Pleasant Lake, in the Parish of Hammond. At this point the following rocks were observed:—

1st. Very compact, dark greenish altered sandstone. Str. N. 75° E. Dip about V.
2nd. The above passes, by containing pebbles, into an indistinct conglomerate.
3rd. The same as the above, but cherty.
4th. Trappean (slightly amygdaloidal) slaty conglomerates.
5th. Light grey conglomerate, with dark olive green spots of chlorite.
6th. A bed of chert.

From the presence of volcanic beds, it may be inferred that the rocks above enumerated may possibly belong to an eastern prolongation of the Coldbrook Group,* and that the latter here marks the northern limit of the Cordaite Shales. From Pleasant Lake eastward the rocks are again interstratified granitic and gneissose sandstones and slates, as far as the boundary of Albert. From where the latter crosses the Shepody Road to the settlement of Great Salmon River, a distance of about eight miles, the only rocks seen were similar to those above described, viz., micaceous slates, of grey and purple colours, and gneissoid sandstones, succeeded as the Bay is approached, by chloritic and clay slates like those of the Little Salmon River. The latter extend westerly, including the Gordon, Alma, and Williams Copper Mines, as far as, and beyond Point Wolf, being, however, separated from the coast by a narrow belt of carboniferous sandstones and conglomerates.

* It is possible, and even probable, that other outcrops of this and the remaining older groups may yet be observed, within the space here assigned to the Cordaite Shales.

From Martin's Head to Point Wolf.—Having now described the district along and south of the Shepody Road, we must next retrace our steps, and returning to the mouth of the Little Salmon River, examine the series as exposed along the coast.

Between the last named stream and Martin's Head, the rocks of the coast belt line the shore, but exhibit no features of especial interest, with the exception that they hold occasional indications of copper ore. The promontory of Martin's Head is partly composed of the present series, and partly of rocks of a later age. The former rise into hills of considerable elevation on the main land, and again reappear, at the extremity of the point, forming high, bold bluffs, of a peculiarly wild and forbidding aspect. They here consist of red and green micaceous slates, holding numerous quartz veins and seams of specular iron. Calc spar of a fine blood-red colour is also common in the crevices of the rock. Reddish beds predominate near the base of the series, while green epidotic slates are more abundant in the upper parts. The whole group of rocks is much disturbed, and has been raised to its present elevation by eruptive agencies, apparent in the large masses of greenish porphyry and epidote, which are well exposed at the outer extremity of the cliffs. Many of the slates are chloritic, and hold veins of quartz and calc-spar, with small quantities of Sulphuret of Copper. They are occasionally penetrated with trappean dykes, and contain a few small seams or veins of poor asbestus.

From Martin's Head to the Vernon Mine, the distance by water is about three miles. Directly in the rear of the former, the rocks of the coast-belt rise into hills of moderate elevation, and extend along the shore as far as the mouth of Goose Creek. They consist of dull purple, red and green slates, conglomerates and grits, the slates being very hard and compact, and seamed through and through with veins of quartz, from a few inches to as much as four feet in thickness.

At Goose Creek the older metamorphic series is separated from the Bay by a small deposit of Lower Carboniferous age, but again reappears, with the same characters as above, at a point about one mile distant from the Vernon mine, and thence occupies the shore without interruption as far as the harbour of Point Wolf. In this portion of its development, and especially at the mine above named, the beds are much altered and disturbed by igneous ejections, which have not only produced foldings and irregularities, but have also greatly changed their colour and general aspect. Epidote is especially abundant, and dykes of trap penetrate the rocks in all directions.

From Point Wolf the rocks of the coast series were found to extend easterly, occupying the entire district south of the Shepody Road, as far as the village of Hopewell, being, however, separated from the Bay by Carboniferous deposits, as indicated upon the Map. They are similar in every way to those of the Salmon River mines, and at various points (hereafter enumerated) show indications of copper ore. At Hopewell they again approach the sea, and constitute the high land in the rear of the village, being

well exposed along the line of the Crooked Creek, and finally terminate in Shepody Mountain.

From Salmon River to Elgin.—While the rocks of the coast belt have been shown to occupy the whole district south of the Shepody Road, observations at various points would seem to indicate that most of the country north of the latter is also composed principally of beds belonging to the same group.

In the examination of a section extending across from the mouth of the Great Salmon River to Elgin, the only rocks differing from those of the coast belt were observed on either side of the great valley of the Coverdale, and consist of highly altered semi-granitic rocks, approaching protogine. These would seem to form two prominent anticlinal ridges, with the slates and shales of the coast belt resting on their sides. The latter occupy an extensive district in Blackwood Block, (where they contain copper ore), and again in the rear of Elgin and along the Pollet River. They are well exposed between the two Falls of the latter stream, where they consist of clay, chloritic and micaceous slates, with dark blueish and reddish pyritiferous quartzites. These are associated with trappean (?) beds of green epidotic rock, and dykes of felspar porphyry.

Many of the rocks at this locality recall those observed in the neighbourhood of the manganese mines in Sussex, and may with the latter constitute a part of the Lower Coldbrook series. Their resemblance to the coast belt, however, is still more marked, and they have been so represented upon the Map. If the latter be the true view of their relations, the locality is an interesting one, as in that case they seem to represent the metalliferous portion of the group.

The section last described may be considered as comprising the extreme width attained by the Cordaite Shales, a distance of not less than twenty eight miles. It would be extremely interesting to ascertain how far this enormous widening of the series is due to synclinal folds, and how far to an actual thickening of the deposit. It would seem that the reversal of the beds observed by Mr. Matthew on the Little Salmon River extends easterly into Albert, and the syenitic and protogine rocks behind Elgin, and south of the Coverdale, may represent corresponding folds in the upper portion of the district. Owing, however, to the distribution of the drift, which covers all except the southern slopes of the valleys, the only dips observed were on the latter and were northerly.

Prosser Brook and Caledonia Mountain.—From its extreme width along the line from Salmon River to Elgin, the group before us narrows but little as it is traced to the eastward. It undoubtedly occupies the whole of the great central unexplored portion of Albert County, and may be seen at many points around the border of the latter. Here, however, it exhibits some new features worthy of more special notice.

The most ready means of access to the interior of the wild lands referred to, is by a somewhat rough road extending southerly from the Carboniferous

basin, and following the course of what is known as the Prosser Brook, a branch of the Coverdale River. This road and stream penetrate to within a few miles of the central point where the Parish lines of Elgin, Harvey and Hillsborough meet each other, and furnishes a geological section of much interest.

From Elgin to the mouth of the Prosser Brook, the only rocks are sandstones and calcareo-bituminous shales of Lower Carboniferous Age. The latter also extend, for a distance of about two miles, southward of the point where the Prosser Brook forms its junction with the Coverdale. The stream then intersects, and in a narrow and wild gorge passes through, a range of hills, overhanging the road in cliffs certainly as much as 500 feet in height. Along the sides of this gorge, which is about half a mile in length, the rocks are well exposed, and are similar to those observed, and already described, as occurring along the road from New Ireland to Elgin, near the upper part of the Coverdale. They are as follow, the succession being in descending order, and in a southerly direction:—

1. Carboniferous rocks, resting unconformably on
2. Granite and altered pyritous slates, interstratified with trap beds.
3. Altered conglomerate and slate.
4. Syenite and gneiss.
5. Altered felspathic slates.
6. Gneissoid and syenitic beds, the latter holding veins of epidote.
7. Altered shales. Str. E. & W. Dip 80° N.
8. Dark trap or altered slate, forming a bed enclosed by syenite.
9. Gneiss. 10. Dark compact trap. 11. Syenite.

The section is terminated by the last named rock, which forms the northern side of an extensive and apparently fertile valley, running easterly, and from its position evidently continuous with that observed near the sources of the Coverdale. This valley, which is of moderate width, is filled with diluvial detritus, and no outcrops of rocks *in situ* were observed. Crossing to its southern side, however, and nearly opposite the first described gorge, is another somewhat similar, but less bold, into which we were enabled to penetrate but a short distance. We here found a tolerable exposure of Lower Carboniferous shales, holding Ganoid fishes, and in every way similar to those of the Albert mines. The shales probably occupy the greater portion of the valley, and extend in the direction of Baltimore, which is but a few miles distant. Their outcrop, however, is but small, and the high hills, which rise abruptly around them, are evidently composed of metamorphic rocks, similar to those observed in the other portions of Albert County.

Baltimore and Caledonia.—Between the mouth of Prosser Brook and the settlement of Baltimore, in the Parish of Hillsborough, following the line of the road, the only rocks observed are Lower Carboniferous. We may, then, consider this line as marking the northern limit of the Cordaite Shales, if to that series all the deposits above described may be properly referred. Our next observations on the group were made at the last named locality.

Leaving the Baltimore Oil Works, which rest on the Lower Carboniferous bituminous shales, and driving in the direction of Hopewell, the land rapidly rises, and rocks of the older series again appear. They are first seen about a mile above the works, and here consist of hard greenish-grey altered slates, (Str. N. 75° W. Dip 40° N.) The high land thus formed, and which is commonly known as Caledonia Mountain, constitutes an extensive and moderately level table-land, extending to a point within a few miles of the coast, near Shepody. Along the top of this elevated plateau, the rocks are hard compact clay slates, (Str. N. 80° W. Dip 50° N.) extending to a point near the Parish line between Hillsborough and Hopewell, where they are succeeded by exposures of a true granite. The latter is abundant, and extends for some distance, being succeeded by syenite and syenitic gneiss, and subsequently, near the southern border of the plateau, by thick beds of olive-green, purple and grey micaceous slates, which are in every way identical with those of the coast belt. Near this point a quarry has been opened in the slates, which were thought useful for roofing purposes, but so far as they were seen by us, they seemed far too soft and splintery, as well as too irregular, to be of any value for that object.

It will be noticed that there is a marked similarity, both in the character and in the succession of deposits, as observed on Caledonia Mountain, with those already described as occurring near the western boundary of the County, on the road from Salmon River to Elgin. They also resemble the altered series of Prosser Brook, and bear the same relation as the latter to the sub-carboniferous shales which rest upon their flanks. This elevated plateau I believe to be higher even than Shepody Mountain, the height of the latter being usually stated at 1,000 feet.

With the last named eminence we close our descriptions of the easterly districts occupied by this wide spread and most important series. Like all the groups which have preceded, the Cordaite Shales now become covered with carboniferous deposits, and rapidly disappear. On Shepody Mountain they may be seen at the Manganese mines, but only in limited outcrops, being overlaid by the thick conglomerates, which constitute the upper half of the eminence. From the latter the land falls off in all directions towards the sea, and, with the exception of a very remarkable locality, hereafter to be noticed, at Beach Hill, near Dorchester, the "coast belt" is not again seen in this direction.

We have yet to notice the occurrence of the same group in, and to the westward of, the City of Saint John.

Saint John City.—In the remarks on the distribution of the Dadoxylon Sandstone, which it will be remembered forms the lower member of the Little River Group, it was stated that the beds of that division occur near the lower portion of the City, resting upon the slates of the Saint John Group. Reposing upon the latter, and forming the extreme southern limit of the peninsula, are found a few beds of the Cordaite Shales. They do not, however, properly constitute a portion of the City, being below tide level,

and only exposed at low water, in a series of reefs. They are fossiliferous, like the beds east of Courtnay Bay, of which they are the continuation, but exhibit no features requiring especial notice.

Carleton.—In crossing to the western side of the Harbour, the rocks of the Little River Group are not immediately apparent, the area intervening between the volcanic Bloomsbury beds and the promontory of Negro Point, being covered with an extensive deposit of post-tertiary clays. A little to the westward, however, at the locality known as Duck Cove, they are again apparent in bluffs upon the shore, resting upon the Dadoxylon Sandstone, and extending in a series of reefs outward below the Bay. It is here that the vegetable remains already alluded to, by which the age of these rocks has been definitely ascertained, are found in the greatest abundance and most thorough preservation. They have been made the subject of special study by Mr. Hartt, who has worked indefatigably in their collection and determination. As the results of this gentleman's labours have never yet been published, it is only just that they should find a place in the present Report, and it is therefore with much pleasure that I here refer the reader to the Appendix, where Mr. Hartt's observations are given in detail.

Pisarinco.—Between the plant-bearing beds of Duck Cove and the peninsula of Pisarinco, the older metamorphic rocks now under consideration, are largely covered and obscured by post-tertiary clays, with marine and river alluvia. The only outcrops yet observed were noticed by Mr. Matthew at Sheldon's Point and Taylor's Island, the peninsula which forms the southern side of Manawagonish Cove. At both of these localities the rocks are chiefly volcanic, with ledges of purple slaty sandstone along the shore, and are probably at the base of the Mispeck Group.

In the peninsula of Pisarinco, as previously stated, the rocks of the Portland Group extend from the southern shore of Spruce Lake southward as far as the embouchure of Mill Creek, of which stream they form the northern side, in a low ridge of metamorphic limestone. The southern shore of the same tide-way is composed of a series of very hard grey and black altered slates and shales, succeeded by thick beds of trappean rock, covered in turn by bright green and purple micaceous slates, dipping southerly, and forming the northern side of Pisarinco Cove.

On the southern shore of the latter, hard blueish-green altered slates and trappean beds, the former holding veins of quartz and specular iron, occur, being especially prominent near Negro Head, and thence extending westerly for several miles. They are probably the western continuation of the rocks of Sheldon's Point. The last rocks observed in this direction were upon the shore near the village of Irishtown, and consist of interstratified beds of hard green and red felspathic quartzite, and dark green basalt.

From the descriptions of Dr. Gesner, it would seem probable that on the western side of the peninsula, near the point known as the Black Beach, the Portland limestones re-appear by denudation, and again on the opposite side of Musquash Harbour. It is possible, however, that the latter may be

of Devonian age, and represent the limestones already noticed eastward of Black River.

In the remarks on the distribution of the Portland Group, it was stated that near the foot of Spruce Lake, north of Pisarinco, and on the line of the Saint Andrews road, occurs a limited deposit of bright red coarse conglomerates. As the Portland rocks re-appear to the southward, these conglomerates would seem to be a detached portion of a newer formation, certainly Devonian, of which the remaining portion has been removed by denudation. This is rendered still more evident by facts observed to the westward.

Musquash.—Between Spruce Lake and Knight's Mills, along the Saint Andrews road, no rocks of a later date than the syenites of the Portland Group appear. At the last named locality, however, as previously noticed, occurs a limited exposure of Devonian beds, consisting of Dadoxylon Sandstone resting upon red sandstones and conglomerates of the Upper Bloomsbury. The latter deposits are comparatively thin, while the sandstone beds attain considerable thickness, and may be traced to the westward for a distance of several miles.

Eastward of the last named rocks, and occupying the greater portion of the space included by the bend of the Musquash River, there rises a ridge of moderate height, known in the vicinity as the Diamond Hill. This elevation, which comprises an area of several miles, is composed of broad bare ledges of coarse red conglomerates, resting upon beds of reddish sandstone. The conglomerates hold pebbles of red sandy slate, white quartz, jasper, and black slate (like that of the Upper Portland beds), and are seamed through and through in every direction with veins of white and limpid quartz. In the latter quite large crystals are not infrequent in the crevices, while those of smaller size are so abundant as to have given origin to the name by which the hill is generally known. The beds have a nearly easterly strike, and dip southerly at an angle of thirty degrees. They are evidently of Devonian origin (probably representing the Little River Group), and are similar in kind to those that have already been noticed on the south shore of Spruce Lake.

From Ivanhoe to Chance Harbour.—That the succession of deposits on the western side of the Musquash River might be compared with those already described to the eastward, in the peninsula of Pisarinco, an examination was next made along a line extending from Knight's Mills, near the western limit of the village of Ivanhoe, to the Bay shore at the settlement of Chance Harbour. Along the road which connects these two localities, the following observations were made.

After leaving the Dadoxylon Sandstone along the line of the Saint Andrews road, and turning southward, the first rocks observed are reddish purple sandy slates. These attain a considerable thickness, and are succeeded, at a distance of half a mile, by beds very similar to those of Diamond Hill, viz., coarse reddish purple conglomerates and sandstones,

filled with veins of crystallized quartz, (Str. N. 70—80° E. Dip N.)—These latter beds extend to a point about half way between Musquash and the shore, where the road from the former forks with those which lead respectively to Chance and Dipper Harbours. Following the first of these, the red beds above described are almost immediately succeeded by a dark green sandstone, dark purple porphyritic slate, and dark green sandy shales. Passing the latter, which are comparatively thin, an abrupt change is apparent in the character of the beds. To the red and purple sandstones and conglomerates, succeeds a series, enormously developed, of hard altered semi-granitic sandstones and pink imperfectly formed granites. The latter, like the former, are distinctly stratified, dipping southerly, and are passed over continuously to a point within a short distance of the Bay shore. Though nearly uniform in character, they occasionally hold a few small beds of dark green altered slate.

At a short distance from the shore at Chance Harbour the granitic rocks are succeeded by deposits of altered grey micaceous schists. These attain but little thickness, and the section is suddenly terminated at the shore by a high basaltic hill, rising abruptly to an elevation of over two hundred feet.

In reviewing the general character of the rocks above described, in connection with those already noticed in the peninsula of Pisarinco, the resemblance to what has been observed in the district immediately eastward of Saint John, is very striking, and well worthy of further notice.

On page 59 of the present Report, in some remarks on the characters of the highly altered sediments of West Beach and Black River, a sectional list of deposits is given, as observed by Mr. Matthew. On comparing the latter with the observations above recorded, the similarity in the character and succession of the beds is too obvious to leave any doubt that, in age and relative position, the two are strictly identical. Each member of the series there enumerated has also been observed on the Chance Harbour road, with the exception of the fourth, holding beds of hematite. As, however, no examination has been made of the surrounding country, and as iron is abundant in the beds of Pisarinco, it is not improbable that this most valuable member will be yet discovered in this neighbourhood.

It has also been stated in the same connection, that to the eastward, the quasi-granite of West Beach passes into schist, abounding with volcanic ash-beds, some of the latter containing large beds of iron ore, and still further to the eastward, is succeeded by thick belts of impure limestone much altered, and hard clay slate with copper pyrites.

It would seem that, while in the district between Musquash and Chance Harbour there is a repetition of the deposits near Beveridge Cove, we have in the beds of Pisarinco the volcanic ash-beds above alluded to, and possibly the thick beds of impure limestone, as previously suggested. This comparison is rendered the more striking by the occurrence in both, of numerous seams of Specular Iron, as well as of slates holding thin veins of Copper Pyrites.

It has been stated by Dr. Gesner, that between Mace's Bay and Point Lepreau, the rocks are thick conglomerates, holding pebbles of trap, porphyry, and serpentine, and filled with veins of quartz. These rocks, according to the same authority, extend as far as Dipper Harbour, of which they compose the shores, while about a mile to the northward re-appears "the great limestone formation," with enormous masses of serpentine. There can be little doubt that the conglomerates are the same as those observed on the Chance Harbour Road, which are certainly Devonian, and it is extremely probable that the same age is to be assigned to the limestone beds. It is, however, possible, that the latter may, as suggested in the remarks on the limestones of Pisarinco, be a portion of the Portland Group, exposed by denudation.

All the beds above enumerated, both those of Beveridge Cove, and those of Pisarinco and Chance Harbour, may be considered as certainly Devonian. It is not yet fully ascertained whether they should be referred to the Cordaite Shales, the upper member of the Little River Group, or be considered as portions of the Mispeck Group, altered by volcanic action.

Lepreau.—Before leaving the consideration of the Devonian rocks of the Little River Group, I desire to make a few observations on the character of the deposits at and around the village and harbour of Lepreau.

In the Report of Dr. Gesner (I. 51—53) it is stated, that at the entrance of this harbour, "conglomerates and *new* red sandstones" appear, composing two small islands, while upon the main land, at the falls of the Lepreau River, are other sandstones "intermediate between the new red, and those forming the upper series of the coal measures." Northward of the bridge, the sandstone is again termed "*new red*," and is said to occupy a low, level country. It is still further stated, that on the south side of the entrance the deposits referable to the coal measures appear, extending along the shore of Mace's Bay to "*The Basin*," where they are *covered* by a coarse conglomerate, and finally by the (new?) red sandstone. The sandstones referred to the Carboniferous Period are stated to contain numerous remains of plants, (including, among others, a Stigmaria), while the rocks themselves have been hardened, and crystals of feldspar formed among the particles of sand.

I have had but little opportunity to examine more than a limited portion of the rocks described by Dr. Gesner, but have no hesitation in saying that a portion at least of the above assumptions are totally incorrect. There can be little doubt that a large part, if not the whole, of the deposits referred to, are neither of Carboniferous nor Triassic origin, but really belong to the Devonian Age. This opinion is based upon the following facts:—

a. It has already been shown that Devonian sandstones and conglomerates, of a red colour, occupy the whole district between Musquash and the shore at Chance Harbour. A slight westerly extension of these rocks would include the Harbour of Lepreau.

b. Between Musquash and the Lepreau Village, the only rocks observed, as far as Hanson's Brook, are syenites of the Portland series. Near the latter stream, coarse dull red conglomerates appear, holding ash-like pebbles,

which in turn rest upon bare ridges of trap. These two rocks would seem to represent, respectively, the Lower and Upper Bloomsbury beds. They extend as far as the village, turning, however, near the latter, a little to the northward.

c. The red sandstones of the Lepreau Falls bear no resemblance to either the New Red or Carboniferous beds seen elsewhere on the coast, while they do strongly recall, by their dull purple tint, many of the deposits of the Upper Devonian.

d. The "New Red" system, so far as observed in New Brunswick, is invariably confined to the very edge of the coast, and never extends more than a short distance inland. As the rocks so called are stated by Gesner to be *covered* by conglomerates, and as the latter are probably continuous with those of the Chance Harbour road, it is reasonable to suppose that both are of Devonian age.

e. The rocks of Saint Andrews, referred by the same authority to the New Red Sandstone and Carboniferous Systems, and described as containing plants, have been shown by Principal Dawson, upon the evidence of the same plants, to be in reality Devonian. Analogy would suggest the same conclusion for the rocks of the Lepreau Basin.

It would, at first sight, appear as if the existence of plants must be taken as positive evidence of the Carboniferous age of the beds which hold them, but when, in the same description, we find that "the small quantity of coal and lignite, has been changed into a kind of anthracite," the impression is almost irresistible, that where the latter occurs the beds are of Devonian age.

It is further stated by Dr. Gesner, that "the strata of conglomérate, extending from Mace's Bay to Point Lepreau, are thick, and composed of pebbles of trap, porphyry, and occasionally serpentine, united by a calcareous cement. They contain numerous veins of calc-spar and quartz, and also afford evidence of the disturbing force communicated to all the formations along the coast." This description applies very well to the conglomerates of Musquash and the Chance Harbour road, while it is very unlike the coastal Carboniferous series. Moreover, the latter part of the description distinctly implies that these beds have undergone flexure with the other (Devonian) formations of the district.

I do not, by the above criticisms, intend to deny that *any* Carboniferous and New Red Sandstone beds occur at this locality. On the contrary, I think it quite possible that *both* may be sparingly represented; but what I do mean to assert is, that a large proportion of the beds above described have not been correctly referred to these formations, but are in reality of Devonian age.

As to the existence of a Carboniferous basin, it is rendered probable by several facts. Among others, it has been stated to me by Mr. Reynolds, of the Lepreau Mills, that he has observed small ($\frac{1}{2}$ inch) outcroppings of coal

in this district, mixed with iron ore, while at New River in Charlotte County, six miles to the westward, Mr. Matthew observed numerous fragments of the same substance scattered over the fields. Upon the latter Mr. Matthew remarks:—"It is difficult to account for their presence here. It is just possible that a thin deposit of carboniferous age may exist under the terrace upon which they are scattered, but it seems more probable that they have come from some part of the Lepreau Basin. This hypothesis would make it necessary to allow the existence of westerly currents during the Terrace Period."

As to the beds of New Red Sandstone, if such really occur in the vicinity of Lepreau, they must occupy very limited areas directly upon the coast. Possibly, as suggested by Gesner, the promontory on which stands the Light House, may be of this age.

Age of the Little River Group.—As previously noticed, the study of the fossils contained in the plant-beds of Carleton, has enabled Principal Dawson to refer the strata in connection with them to the Chemung and Portage Groups of the Upper Devonian Series.

Topographical Features.—After the details now given of the character and distribution of the Cordaite Shales, it will not be necessary to enter into a minute description of the extensive district which they occupy. It is sufficient to say that the latter is among the wildest and most rugged in the Province, intersected by numerous streams, whose courses for miles occupy the bottoms of deep defiles, and rising along the shore of the Bay of Fundy into cliffs and lofty ridges of great grandeur. An excellent idea of the peculiar scenery may be gathered from the description, already given, of the Little Salmon River. From the mouth of the latter to the Harbour of Point Wolf, the height of the land will average from six to seven hundred feet, and near the Vernon mine rises to a still greater elevation.

Agricultural Capabilities.—Although not to be considered as producing soils of superior quality, the character of the land overlying the Cordaite Shales cannot be looked upon as so utterly barren as in the case of some of the groups already described. Many portions of the district occupied by these rocks are, indeed, remarkable for their sterility, but, taken as a whole, the land is usually well wooded, and affords, both in the excellent supply of timber and the abundance of water-power, excellent opportunities for the lumbering trade. Few attempts have yet been made to cultivate the land, which is mostly in a wild state, and roads are greatly needed, both for the development of its agricultural and mining capabilities.

Useful Minerals.—*A.* Dadoxylon Sandstone.—As far as known, the lower member of the Little River Group is entirely destitute of valuable minerals, and may therefore be dismissed without further consideration.

B. Cordaite Shales.—It has already been repeatedly stated that the rocks of this division, constituting the upper member of the group now

under consideration, may be regarded as the great metalliferous series of Southern New Brunswick. Having now offered the proof of their Devonian age, as well as described in detail their characters and distribution, we have only to call attention to the several points at which productive ore-beds have been observed.

The metals which have so far been found in the rocks of this series are iron, copper, and manganese.

a. Iron Ores.—The principal locality for this metal is the district in the vicinity of West Beach and Black River, where several large beds of hematite occur. As they are well known, and were described in my Report of last year, it is not necessary to make further allusion to their character, than to say that one portion of the ore occurs in a coarse reddish-grey conglomerate, the other, two or three miles to the eastward, in beds of trappean and micaceous slates. These rocks have been shown by Mr. Matthew clearly to form a portion of the Cordaite Shales in the Devonian series.

Besides the ore-beds alluded to, iron is abundant in seams and veins through most of the rocks occurring in this district, and it is not improbable that further search would reveal the latter in available quantities.

The only remaining district likely to be productive of this metal is the peninsula of Pisarinco. I have already alluded to the resemblance between the latter and the beds of Beveridge Cove, and stated that specular iron is not uncommon in its southern portion. Were the metal in greater demand, its presence in this region might be looked for with very good prospect of success. The same is true of the district lying to the west of Musquash Harbour, and thence towards the Basin of Lepreau.

b. Copper Ores.—The most important and well known localities of copper, appertaining to this series, are the mines occurring in the eastern portion of Saint John, and western portion of Albert, Counties. In the district alluded to, between Martin's Head and the settlement of Great Salmon River, no less than four distinct attempts have been made to carry on operations, with varying success. These constitute respectively the Vernon, Alma, Gordon, and Williams Mines. The three latter were visited by myself in the summer of 1868, and described in my Report of that year; the former, though also alluded to in the same Report, was not visited until the past season. It may therefore not be out of place to add a few observations, made by Mr. Matthew and myself, upon its present condition.

The Vernon Copper Mines are situated upon the Bay Shore, about three miles eastward of Martin's Head, and about two from the mouth of Goose Creek. The rocks in which operations have been begun are metamorphic beds of the Bay Shore belt, which here rise abruptly from the level of the sea to a height varying from six to eight hundred feet. Their character has already been described. They consist of dull purple and grey micaceous slates, conglomerates, and grits, much injected with igneous matter, and holding veins of quartz, calc-spar and chlorite. They are in every way identical with the rocks of Martin's Head and the region to the westward,

ters' Inn, occurs a very singular metalliferous locality, but recently discovered, and which opens a new field of investigation in a district heretofore supposed to be destitute of metal-bearing rocks.

The precise locality where this discovery was made, is on the land of Joseph Landry, constituting a portion of the settlement known in the vicinity as Beech Hill. The land has been leased from its owners by Mr. Alex. Wright of Salisbury, with whom I paid a visit to the spot during the past season.

In examining the district where the ore occurs, I found that the land immediately surrounding the lode is everywhere covered with rocks of carboniferous age, over the surface of which are scattered innumerable boulders of highly crystalline quartz. The beds from which the latter have been derived are not directly visible, but near the point where they are most abundant, a pit has been sunk to a depth of about five feet, exposing a distinct quartz lode of from four to five feet in thickness. This lode has a course about N. 22° W., a nearly perpendicular dip, and is bounded by regular walls. Only one of the latter was distinctly visible, and consisted of buff-coloured and reddish altered grit or breccia. Covering the latter, as well as a portion of the lode, are an ochreous clayey conglomerate, then a reddish slaty clay, and finally over all some two or three feet of soil. These uppermost deposits have a decidedly carboniferous look, and are destitute of metallic indications.

The ore, which is confined to the quartz lode, is the grey sulphuret, and is scattered through the rock in veins and spots, while, by alteration, it has given a green tinge to much of the associated gangue. A portion of the quartz is distinctly, and at times finely, amethystine, (indicating the presence of manganese). Barytes is also found in the lode, and specimens from the neighbourhood contain a green variety of fluor. There seemed to be an entire absence of calcareous matter.

Hoping that some exposures might be found in the neighbourhood, by which the age of the deposit could be ascertained, I made a careful search, but found no beds *in situ*, with the exception of carboniferous sandstones, shales, and conglomerates, the former holding characteristic plants. Boulders, however, were common, and evidently derived from a metamorphic series, such as gneiss, syenite, mica schist, green and ashy slates.

This locality is certainly an interesting one, and worthy of further exploration. It would seem to imply an easterly prolongation of the metalliferous coast belt, as well as a great thinning out of the carboniferous beds by denudation. It is not unlikely that similar exposures, from which the boulders have been derived, may be discovered in the neighbourhood.

g. Black River Settlement, on the Mountain road from Loch Lomond. *Ore*—Copper pyrites and the green carbonate, in hard clay slate.*

h. Pisarinco. Yellow sulphuret of copper has been found in the altered slates and grits of this peninsula, but not in profitable quantities.

At all the above named localities, the rocks are certainly members of the upper division of the Little River Group. In those which follow, the beds are probably portions of the same series, but, as expressed in the remarks on the characters of this group, their position has not been ascertained with absolute certainty.

i. Blackwood Block, Albert County. I am informed by Mr. Matthew, that in this district, and near the lake which forms the source of one of the branches of the Salmon River, copper has recently been found by Mr. G. F. Keans of Saint John.

The latter gentleman observed some veins, and numerous boulders, of quartz on the hillsides about the lake, as well as felspar, mica, (silvery grey and black) horneblende, actinolite, and chlorite. The copper was observed in a ledge of hard grey metamorphic slate, on the north side of the lake, filling seams in the rock, and is a green carbonate, not the original ore. The accompanying rocks are described as paler and coarser slates, some of the latter having an ash-like aspect (volcanic?), and reddish felsite. All of these rocks are similar to those occurring in the Cordalte Shales, or cupriferous band of the coast. Both of the above-named gentlemen, to whom I am indebted for the facts of its occurrence, regard the locality as a promising one, and deserving of further examination.

This locality is not very distant from the point at which particles of drift gold were observed by myself and others in the summer of 1863. The occurrence of the latter is curious, and difficult of explanation. It can scarcely be supposed that this metal should have come from beds of Devonian age, such as those of the neighbourhood appear to be. Neither are there any rocks of a greater age in this portion of the Province, unless we suppose the re-appearance of the Saint John slates, or some portion of the Coldbrook and Portland Groups. As to the former, as far as observed to the eastward, no approaching alteration, such as is usually found in gold-bearing series, was observed, and eastward of King's County the group itself appears to be entirely wanting. The same is true of the Portland Group, but it is not at all unlikely that beds of the Coldbrook may be represented in this district, and to them we must provisionally look for the origin of this metal. It should, however, be borne in mind, that Dr. Hayes of Boston, has, by analysis, ascertained the presence of gold in the rocks of the Vernon mine, also a part of the series of which the locality at Blackwood is supposed to form a member.

k. Beech Hill, Westmorland. On the south-eastern side of the Memramcook River, in the Parish of Dorchester, and about three miles from Char-

* Observed by Mr. Matthew.

GENERAL REMARKS UPON THE DEVONIAN.

A. Origin of the Beds.—After the minute descriptions which have now been given, it will not be difficult to understand the origin and succession of the several formations, which constitute in Southern New Brunswick the Upper Devonian Series.

Ushered in by a period of intense volcanic activity, which moreover seems to have been renewed at various intervals, and was again prominent near its close, the Upper Devonian age presents a succession of deposits, partly of volcanic and partly of sedimentary origin.

The great bulk of material which now constitutes the lower member of the Bloomsbury Group, consisting of basalt, amygdaloid, trap-ash, and conglomerate, may, in part, have been produced above the level of the sea. From the compact character of its rocks, however, and their association with aqueous sediments, it seems more probable that the eruptive outbursts were, for the most part, sub-marine, or at least under the influence of oceanic currents. The associated beds, while they indicate the presence of moving waters, do not imply that those waters were deep, and we may readily suppose the existence of volcanic vents so near a coast, that materials, discharged from the former, may have fallen into, and been re-assorted by the currents of the latter. The presence of conglomerates with the volcanic rocks confirms this view of their origin.

It is noticeable that the rocks which immediately succeed the eruptive beds are of a bright red colour. It has been remarked by Mr. Matthew, that such association of reddish sediments, with volcanic outbursts, is of almost invariable occurrence, the former appearing to be a consequence of the latter.

Between the lower member of the Bloomsbury and the upper member of the Little River Group, so great is the variety and so constant the alternations in the several beds, that no one description would prove applicable to them all. Many kinds of rocks, conglomerates, sandstones, and shales, occur in oft-repeated succession, and are evidences, as already observed, of as many changes in the physical conditions under which they were deposited. Coarse conglomerates, where they occur, are an indication of rapidly moving currents in shallow waters, or of wave action on exposed shores; sandstones are indicative of more tranquil waters, though still too much disturbed for the accumulation of finer sediments; while slates and shales are composed only of those materials, which, sheltered from the waves and currents, have been slowly reduced to the finest mud. It is in these latter, also, that we most frequently find traces of those organic relics, which, more than any merely mineral characters, give us evidence of the age and origin of the beds which bear them.

In the several groups of the Devonian, all the varieties of rocks above enumerated occur, with the addition of volcanic sediments, which seem to have been produced in varying quantities through the whole age, and some

thick beds of limestone. None of the rocks, with the exception of the last, bear evidence of a deep water origin, while the fossils, so abundant in some portions of the Little River Group, even imply the presence of marshes and dry land. The limestones, as remarked under the observations on the Silurian, may have been the result either of organic secretion or chemical deposition. For the reasons there stated, the former is considered the more probable explanation.

B. DISTURBANCES AND FOLDINGS.—To those at all familar with the general character and aspect of the district occupied by the Devonian Rocks, it will scarcely be necessary to state that the various formations which these rocks compose, do not now occupy the horizontal position in which they were deposited. They have been violently and powerfully disturbed, uplifted, and pressed into gigantic folds. Where still soft and pliant they have yielded to the pressure, and we find their curved and bending strata giving evidence of the fact; where too firmly consolidated to admit of flexion, they have cracked and broken, giving rise to enormous fissures, not unfrequently filled with the eruptive matter which was the cause of the disturbance.

To form a just idea of the character and amount of these enormous dislocations, it will only be necessary to glance at one or more of the different Sections* appended to this Report. These Sections, which are three in number, are designed to represent the general structure, arrangement and position of the different geological formations in the lower portion of the Province, extending from the County line of Queen's to the Bay of Fundy. They are not merely ideal, but are based upon the results of actual examination, and illustrate, much more clearly than can be done by any verbal description, the general relations and disturbances of the different groups in the districts which they represent. The Key appended to the Sections, together with the numbers indicative of the several groups, and the topographical references, will enable those interested in the subject to readily understand the explanations which follow.

In the examination of the First Section, representing the structure of the district along a line from the granite of Nerepis to the Bay Shore at West Beach, it will be seen that there are three anticlinal axes, (two of great, and another of lesser maghitude,) with four, and perhaps five, corresponding synclinal folds. The former are marked by the position of the Portland Rocks south of Kennebeckasis Bay, and of the Lower Bloomsbury Group, east of the Mispeck, while between the two is seen a smaller anticlinal, and an extensive fault, near Beaver Lake. The two great ridges of the Portland and Bloomsbury Groups thus form the outer limits of a valley, divided however near its centre by the high gravel beds of Mount Prospect, in which are now found in regular succession the Coldbrook, Silurian, and Devonian beds. The latter, but not the former, re-appear again southeast of Bloomsbury Mountain, at West Beach, and Black River.

*Prepared by Mr. Matthew and myself.

In the western portion of the Section no details are given, the extreme metamorphism of the Portland and Kingston Rocks rendering all observations on their inclination very difficult and unreliable. There would seem, however, to be a general northerly dip along the Kennebeckasis and the peninsula of Kingston, while beyond "the Reach" the dip is reversed, and has a southerly direction, the Saint John River occupying the synclinal depression between the two.

It is important to observe that between the Azoic, Silurian, and Devonian Groups, there is a general conformability through all the folds, but that in the Kennebeckasis valley, Carboniferous rocks rest upon the upturned edges of the former.

On comparing the Section just described (A) with that indicated under (B), and which extends along a line nearly parallel to, but eastward of the former, several prominent points of difference will be apparent.

The Portland Group still forms a central anticlinal, and from it, as before, the Coldbrook and Saint John rocks dip southerly. The Bloomsbury beds still occupy the same position (with the Devonian and Carboniferous formations resting on their southern slope), but no longer as an anticlinal; disturbances, upheavals and downthrows having altered the relations of the different groups, and brought to view deposits which, in the previous section, were concealed below the surface. The cause of the changes here alluded to, is evident in the ridge of eruptive syenite north of Negro Lake, which has produced a secondary folding and a dislocation of the adjacent beds. By this folding the Saint John rocks are again exposed, and to the southward re-appear in their natural sequence. The western portion of the section differs from the one first described, only in the gradually increasing prominence of Sub-Carboniferous deposits, which, as before, rest upon the older series unconformably.

In the Third Section, taken along a line still farther to the eastward, the changes already begun in the second section become still more apparent, and several new features are introduced. It will be seen that the great mass of the Lower Bloomsbury Group, before so prominent, is no longer seen, though possibly indicated, in part, by the depression of Nugent Lake, while the Lower Coldbrook beds, wanting in the southern part of the first section, and but slightly visible in the second, are now enormously thick, and constitute the one great anticlinal upon which the other groups repose. The Portland Rocks have entirely disappeared (at Hammond River), and are not again found to the eastward, the place which they before occupied being now filled with the high conglomerate ridges of Upham and Salt Spring Brook. None of the older series are again seen to the north, with the exception of the Kingston Rocks, divided by the valley of the Belleisle, and partly covered with Carboniferous beds.

In the southern portion of the Section (near Quaco), some other changes of great interest will be observed. In addition to the Carboniferous deposits,

which are here represented as at M'Kay's Head, an entirely new series is introduced in the Triassic or New Red Sandstone formation, lying unconformably upon the Carboniferous strata, as these, in turn, are unconformable to the Devonian beds below them. The relations of the different groups are still further complicated by the presence of enormous dykes of eruptive basalt, constituting the bold promontory of Quaco Head, and violently disturbing all the overlying beds, with the exception of the New Red Sandstone. As this portion of the district is particularly interesting, a second, ideal Section (D) has been prepared upon a larger scale, where the relations of the different groups may be seen as viewed from the surface of the Bay. This section will be more fully described in the remarks on the Carboniferous formations of the coast.

In pursuing the investigation of the districts to the eastward of those above represented, the most marked changes are the entire disappearance of the Coldbrook (or Huronian?) Series, near the eastern side of the County of King's, and the enormous widening of the Cordaite Shales. The details of the latter, from the wildness of the district, are too disconnected for the construction of another section parallel to the last; but, as already noticed, there would appear to be one or more synclinal, and corresponding anticlinal folds along the Little Salmon River, and in the central portion of Albert County. Still farther eastward, a section in the valley of the Petitcodiac, would show only Carboniferous deposits, almost completely concealing the older series, at Prosser Brook and Shepody Mountain.

From a comparison of the three Sections above described with the Geological Map, it will at once become apparent that the general direction of the folds is very regular, a little north of east, and approximately parallel to the northern shore of the Bay of Fundy.

This direction coincides with what has been observed in other portions of America, and indicates that the force producing the disturbance, must have acted uniformly over immense districts. What the nature of the force it is difficult to say, but that its power was enormous will be sufficiently evident from the descriptions already given of the effects produced. That it was exerted in a direction *from* the sea, would also seem to be probable, a fact long since noticed along the entire Atlantic coast, where it is most evident in a general prevalence of easterly dips. In New Brunswick the force has not been sufficient to produce the latter, (as will be seen from the sections,) but the same conclusion would still seem to follow from the occurrence of all the downthrows on the northern sides of the anticlinals, *i. e.* on the side most remote from the ocean.

The most remarkable of these faults and downthrows is that already noticed as occurring near Negro Lake and Ratcliffe's Millstream, south of Loch Lomond, and illustrated in two of the accompanying Sections. By comparison of the position of the different groups represented, it will be seen that the amount of displacement is equal to the entire thickness of the Lower

Coldbrook Group, not less, therefore, than 5,000 feet. Even this, however, would seem to be exceeded by the tremendous fault now indicated by the valley of the Kennebeckasis, if, as is probable, the latter was formed, like the above, at the close of the Devonian Age. Supposing the Kingston rocks to be only Upper Silurian, we still have a downthrow equal in vertical depth to the entire thickness of the latter, added to that of the Lower Silurian, (Huronian ?), and part of the Laurentian ; for we now find the former, (*i. e.* the rocks of Kingston,) side by side with the limestones and syenites of Portland.

Such were some of the physical changes, which cause the Devonian Age to stand out so prominently in the geological history of this portion of the continent.

C. METAMORPHISM.—It will readily be believed, after a consideration of the enormous power exerted upon the rocks of the Devonian Series, whereby they have been changed in position, and thrown into such gigantic folds, that the mere flexion of the beds was not the sole nor even the principal result produced by these disturbances. The characters of the rocks themselves have undergone a marked alteration, whereby sandstones, conglomerates and shales have been hardened and solidified, and limestones have lost all traces of their organic origin ; or it may be the process of alteration has advanced still further, and resulted in a complete crystallization of the beds, the evidence of their original character being thereby obliterated.

We have already had occasion to offer some remarks on the subject of metamorphism, as illustrated in the deposits of the Azoic and Silurian. In the groups now before us, constituting in New Brunswick the Upper Devonian Series, we have this process more fully exemplified in all its stages. These may be most conveniently treated under the three heads of consolidation, partial alteration, and crystallization.

a. Consolidation.—This is the first step in the process of metamorphism, and consists of a simple hardening of the sedimentary beds. All of the Devonian rocks have undergone this change in a greater or less degree, what were formerly deposits of sand or pebbles, becoming hardened into refractory sandstones and grits, while soft and friable shales have been changed into compact and unyielding slates.

Such consolidation is partly the result of heat, and partly of aqueous solutions. The cements most commonly occurring among the Devonian rocks are calcareous and silicious. The great quantity of the latter in particular localities is well illustrated in the eminence known as Diamond Hill, east of Musquash, where the abundance of the quartz, cementing the conglomerates, is truly wonderful. Iron seems also to have been an active and very common agent in producing consolidation, especially in the Little River Group, where the abundance of this metal is shown, not only in the frequency of ferruginous veins, but also in the red tint which characterizes the larger portion of its beds.

b. Partial Alteration.—From the mere consolidation of loose materials to their partial metamorphism, the step is a short one, while the latter in turn passes by insensible stages into a complete crystallization, whereby the characters of the original substance are lost, and new mineral aggregates are produced. This partial metamorphism is best illustrated by the changes thus wrought upon the *organic* contents of the beds, giving rise to distortion of the forms in animal fossils, or a debitumenization of those belonging to the vegetable kingdom. These changes are well marked in some of the beds of the Little River Group, especially in the Dadoxylon Sandstone and the fossiliferous portion of the Cordaite Shales. In the former, the remains of trunks of trees, such as the great Conifer termed *Dadoxylon*, first changed into seams of ordinary coal, have now, as noticed by Mr. Matthew, been converted into anthracite, while in the latter, the ferns and other delicate plants have undergone a still greater alteration, and are now found to have the lustre and character of graphite.

Among other effects produced by partial metamorphism, the most common and the most important are changes in the composition of mineral veins, or alterations in the colour of the enclosing beds. Such changes may be the result of a moderate and gentle heat only, and consist of a simple loss of water and other vaporizable constituents, as when the iron ore termed *Limonite* is converted into *Haematite*, or a more powerful heat may have been necessary, a heat sufficient to produce sublimation, giving rise to the escape of vapours and mineral solutions.

All of the changes here mentioned are common among the rocks of the Devonian Series in New Brunswick, the former in the great variety of colour characteristic of the sedimentary beds, and which is largely due to the presence or absence of combined moisture, the latter in the effects produced where the disturbances have been most active, and igneous ejections most powerful and frequent. The whole coast of the Bay of Fundy, occupied by rocks of this age, is filled with such evidences of partial metamorphism, while at Martin's Head, and about the various Copper mines, they are especially remarkable. Veins of calc-spar, naturally of a pure white colour, have been changed to a rich crimson red, epidotic and chloritic veins penetrate the rocks in all directions, while the accompanying ores themselves have undergone similar alteration, oxide of iron becoming changed into the specular variety, or the dull-coloured sulphurets of copper into glance and peacock ore.

c. Crystallization.—This third and most complete stage in the process of metamorphism, is that by which the original character of stratified deposits is completely destroyed, and the ordinary beds of sand and clay converted into crystalline granite, syenite, and gneiss,—a change already illustrated in the highly-altered deposits of the Azoic Age.

In several of the Devonian groups a similar but more partial alteration has already been pointed out. The semi-crystallized rocks of Black River and Chance Harbour are but imperfectly formed granites, which a very slight

continuance of the metamorphic influences would have converted into compact unstratified beds, not to be distinguished from the similar formations produced by purely igneous agency. The same may also be said of the semi-granitic and protogine rocks, associated with the upper member of the Little River Group, in the County of Albert.

There are, however, extensive districts in various portions of the Province, where the process of crystallization has reached its extreme limit, and where we can no longer directly trace any evidence of sedimentary origin, the deposits of clay and argillaceous sand having become converted into micaceous slates, gneiss, syenite, and true granite.

The districts occupied by these rocks, being among the largest in the Province, require a more extended notice.

Devonian Granites.—*a. Distribution.*—The general position and extent of the great granitic belts of the more central portions of the Province, have already been pointed out in the introductory Chapter. Not being directly included in the district examined during the past season, a small portion only of their distribution is represented upon the Map. They are two in number, the general outline and position of which may be described as follows:—

The first, or great central belt, entering the Province from the State of Maine, passes through the Counties of York, Northumberland, and Gloucester, and extends to within a short distance of the Bay of Chaleur, at Bathurst. Its northern limit is a line, starting from the North Lake, near the Monument Brook, on the boundary, passing between the first and second Eel River Lakes, on through the neighbourhood of the Howard Settlement, to the Saint John River, above the Meductic Rapids. Crossing the latter, it trends northeasterly near the head-waters of the Miramichi, and strikes the Nepisiquit River a few miles above the Grand Falls of that stream. The southern boundary is approximately parallel to the northern, crossing the Saint John River four or five miles below the mouth of the Pokiok, but is much more widely separated to the west than to the east, where, near Bathurst, the width of the belt becomes greatly reduced. It will be observed that in the latter direction, as well as at the crossing of the main river, these outlines differ materially from those heretofore represented.*

The second great band of granitic rocks, also entering the Province from the State of Maine, extends from the neighbourhood of Saint Stephen, with some interruption, to the Saint John River, where it is abruptly terminated opposite Spoon Island, below the village of Hampstead. It is here somewhat over a mile in thickness, being partly covered on its northern side by argillaceous and micaceous slates, and on its southern, by the rocks of Kingston.

* For the particulars of the occurrence of this granitic belt, and the associated slate formations at Bathurst, see the Report of last year; also, an Article on the Geology of the Nepisiquit, in the Canadian Naturalist.

b. Characters.—In mineral composition the first of the above great series is remarkably variable. It may be well studied at and near the mouth of the Pokiok, where this stream, running through a narrow gorge not more than thirty feet in width, but over a hundred in depth, falls into the River Saint John. The most abundant rock at this locality is a coarse reddish syenite, divided by irregular joints, (to which the course of the stream is due), associated, however, with some true granite, (consisting of quartz, white felspar, and black mica). Much of the latter is very coarsely porphyritic, large crystals of felspar, sometimes two inches in length by one in breadth, composing a large proportion of the rock, and projecting on its weathered surface in grey and white angular blotches. This porphyritic granite is very abundant throughout the central belt of York, and is scattered in boulders over a large portion of the County. In this respect it differs greatly from the other series yet to be described. To the north of the Pokiok, and between that stream and the Shogamoc, the granite contains some beds of gneiss passing into mica slate, while veins of finer grained granite, with others of compact crystalline felspar, occur at various points.

The granites of Queen's County differ from those above described, chiefly in their more compact and even texture. So far as I am aware, they are never coarsely porphyritic, and are more constant in composition. Along their eastern terminus, where they have been extensively quarried, they are true granites, being composed of quartz, light-coloured felspar, and black mica, in nearly equal proportions. They have been described by Gesner as approaching gneiss, but the appearance of stratification, which that author observed, is, I think, due solely to a system of joints, by which all these granites are characterized, and which is of great service in the process of quarrying.

To the westward, along the line of the Douglas Valley, the granites become somewhat coarser, and at Fall Brook hold considerable quantities of *schorl*, or impure black tourmaline.

c. Age.—In series so extensively altered as those now under consideration, the only facts upon which our conclusions can be based, are their stratigraphical relations, and the analogy of adjacent districts.

As to the former, it has already been noticed, that throughout their entire extent the granites of York are flanked on either side by nearly perpendicular series of slates and quartzites, while in the Parish of Prince William, both are covered by rocks of the Lower Coal Measures, which rest upon their upturned edges unconformably. It is therefore evident that the period of upheaval and crystallization in the former, must have been subsequent to the deposition of the mica slates, yet antecedent to the opening of the Carboniferous era. Judging from the phenomena exhibited in other portions of the Province, it seems probable that the Devonian Age, so remarkable for the number and extent of its volcanic outbursts, withessed also the disturbance which is here referred to. It is, however, possible, that such dis-

turbance may have taken place at an earlier date, or even at several widely separated epochs. The latter supposition would seem to be directly proved by the presence of granite veins passing through the earlier series, and producing a secondary alteration of its constituent minerals.

The above view of the age of the New Brunswick granites, excepting those of the Portland and Kingston Groups, is confirmed by the analogy of Nova Scotia, where, according to Dawson, rocks of this character and age penetrate the formations of the Upper Silurian and Lower Devonian.

d. Topographical Features.—The central granitic band of New Brunswick is for the most part high and rugged, although less so than the formations in the northern portion of the Province, or the southern band of the Nerepis. The latter affords some of the wildest and most lofty scenery in New Brunswick, including Bald Mountain, Douglas Mountain, the Eagle Cliffs, and many other eminences. Over both districts there is little soil beyond that furnished by the "Drift," and the country is in almost all parts an unbroken wilderness.

e. Useful Minerals.—Indications of Tin have been said to occur in the rocks near the mouth of the Pokiok, but after a careful search, I have found nothing to warrant a belief in the existence of metals at this point. Beyond their application for building purposes, for which the granites of Queen's County are admirably adapted, the rocks of these series are without economical value.

Condition of this portion of the Continent during and at the close of the Devonian Age.

It will be remembered that in the remarks on the close of the Silurian Age, it was stated that the character of the rocks then forming in this portion of the Continent, seem to indicate a gradual sinking of the land beneath the sea. The upper beds of the Saint John Group are deep-water formations, while those of Kingston, in many parts at least, also indicate a similar origin. How long this subsidence continued, or whether any portion of the groups was again elevated to form dry land, during the long interval which elapsed before the opening of the Upper Devonian Era, it is impossible from our present data to determine. As, however, the latter epoch approached, it is probable that all those portions of the Province now occupied by the rocks of the Bloomsbury, Little River, and Mispeck Groups, with many others from which these beds have since been removed by denudation, were still covered by the ocean, for the volcanic products of the former indicate an origin under pressure, which could alone have been produced by outflows beneath the sea.

It does not necessarily follow that the waters then covering the land were deep, and as we pass to the upper member of the group, the evidence of strong but shallow currents, producing coarse conglomerates, indicates a gradual period of emergence. During this and the succeeding epochs, a

series of minor oscillations, marked by the alternations of coarser and finer beds, prevailed throughout the course of the Era. As the latter, however, drew slowly to a close, a period of disturbance, upheaval, metamorphism, and mountain-making, began upon a grand scale. The strata previously horizontal, or nearly so, were pressed into gigantic folds, the span of which is sometimes as much as several miles, and the original height not less than 2,000 feet, while at the summit of the folds, where the strain was greatest, dislocations ensued, resulting in the formation of extensive fissures, and the outflow of igneous matter. Accompanying the escape of the latter, began that general process of alteration and metamorphism which, as we have seen, characterizes so large a portion of the deposits belonging to this age. Then, too, the vapors and chemical solutions, filling the cracks and fissures, commenced those changes which have resulted in the formation of mineral veins, which abound in many portions of the districts described, and give to them their economical value.

Before leaving the consideration of the Devonian Age, we may add a few words on its peculiar *Life*, for it is here that we first meet with undoubted indications of a *land* vegetation. It will be remembered that vegetable fossils, of an obscure and doubtful character, have already been noticed as occurring in deposits of a much older date, even as low as the Saint John Group, and the upper beds of the Portland. In all these, however, the remains are too poorly preserved to be easily made out, and are, without exception, *marine* plants, of the very lowest order of organization. In the Upper Devonian sandstones and shales, however, a great advance has been made, in the change from a *marine* to a *terrestrial* vegetation. In place of the low and humble sea-weeds, which represented the entire vegetable world in the earlier periods, we have now to contemplate the Continent as raised in part above the sea, and clothed with Ferns and Conifers.

Among the most remarkable and constant of these plant-remains, is the fossil called the *Dadoxylon*, from which the name of one member of the Little River Group has been derived. This plant (*Dadoxylon Ouangondianum —Dawson*,) seems to have been a coniferous tree, of considerable size, some of the trunks, which are common in the sandstone, being as much as a foot or more in diameter. They are sufficiently preserved to show the pith, and, occasionally, even the rings which marked their annual growth.

Besides the pine-like *Dadoxylon*, the sandstones and shales contain the remains of numerous *ferns*, beautifully preserved and of great variety, and with them numerous Calamites, plants closely allied to the *Equisetum* or *Scouring Rush* of our marshes.

Nor are there wanting evidences by which we may judge of the animal as well as the vegetable life which flourished in this portion of North America at that early period. Not the least interesting of the discoveries made in the rocks of the Devonian Series, was the finding by Mr. Hartt of the undoubted traces of an *insect* life, the wings of these animals being, like the Ferns, beautifully preserved in the softer shale. They are by no means so abundant

as the other fossils referred to, but they are quite sufficient to prove the existence of these animals in the Devonian forests, and thus to establish the fact of their introduction upon the globe, at a period earlier by a whole geological age than that which had heretofore been assigned them.

In the disturbances which marked the close of the Devonian Age, most, if not all, of this abundant life became destroyed, and with a few exceptions, all evidence of its existence obliterated.

CARBONIFEROUS AGE.

The Carboniferous Age, or Age of Coal Plants, is usually divided into three Periods—the *Sub-Carboniferous*, when *marine* beds were mostly in process of formation;—the *Carboniferous*, when, over much of the Continent, the land had been sufficiently elevated to form wide-spread plant-sustaining marshes, giving rise to deposits of vegetable matter, now converted into coal;—and the *Permian*, when the sea again covered extensive districts. Of these, the two first mentioned periods only, are believed to be represented in New Brunswick.

A.—SUB-CARBONIFEROUS SERIES.

DISTRIBUTION.—The rocks of the Sub-Carboniferous Period in New Brunswick, like those of the same formation in Nova Scotia, occupy an extensive area, being not only widely spread over a district where no other rocks appear, but also occurring in isolated masses, irregularly distributed among the beds of the older groups, partially filling the depressions produced by the folding of the latter, or even rising along the sides of the ridges, and at times towering above their summits.

The general distribution of the Series will be apparent from a glance at the Map, where the beds comprising it are represented by a bright vermilion colour. As they are much more easy of recognition than the older formations on which they lie, they will not require so minute a description. The following are the principal areas which they occupy:—

1. The Valley of Belleisle Bay, and its extension easterly towards Butternut Ridge; also the Valley of the Kennebeckasis, and its extension easterly, along the Petitcodiac, to Moncton. This latter valley, near Norton, unites with that of the Belleisle, the Sub-Carboniferous rocks extending thence through a large portion of King's, Albert, and Westmorland Counties.

2. The Valley of the Petitcodiac, between Moncton and Shepody Bay. This division includes the district about the Albert Mines, with the asphaltic and bituminous shales of Elgin, Hillsborough, Baltimore, Dover, and Dorchester.

3. Detached areas upon or near the Coast. Of these, the principal are the neighbourhood of Gardner's Creek, with the region around Quaco, Martin's Head, Goose Creek, Point Wolf, and Salmon River.

4. The border of the great central Carboniferous Basin.

5. The Lepreau Basin, Charlotte County. The occurrence of Carboniferous rocks at this locality is not certainly known.

6. On the Tobique River, in the County of Victoria, between the Red Rapids and the Blue Mountains.

The above separation into divisions will be found convenient, not only as a geographical classification, but also as associating together deposits most nearly alike in character. These latter will now be more fully described.

CHARACTERS.—1. *Valleys of Kennebeckasis and Bellisle Bay.*—In this portion of their distribution, the rocks of the Subcarboniferous Period, as first pointed out by Mr. Matthew and Dr. Dawson, consist of materials mostly derived from the older metamorphic ranges on which they rest. These materials are usually of a coarse description, and, cemented together, produce a rough conglomerate, usually of a bright reddish-brown colour, with which, however, are associated some finer beds of sandstone and shale. Mr. Matthew thus describes the composition of those which occur in Kennebeckasis Bay:—

"Paste.—Dark red clay or sand, derived from granite,—rarely a gray calcareous mud.

Pebbles.—Imperfectly rounded fragments, one foot or less in diameter, of 1st, Granite or Syenite; 2nd, Metamorphic Limestone; 3d, Mica Slate; 4th, Soft brown sandstone.

These rocks, except the last named, are derived from beds of the Portland Series." They fill all the upper part of the valley, and have been traced along the line of the river, as far as Apohaqui Station, near Sussex. They also cover, wholly or partially, many of the islands in Kennebeckasis Bay, and though in its lower portion mostly removed by denudation, are still represented in isolated patches, or lengthened strips, along the shore. They constitute the larger portion of Long Island, (where, however, older beds also appear,) and rise into a bold bluff at its eastern end. They form a part of the shores of the Milkish Creek, and are also seen on the southern shore of the Bay, covering most of the district between Boar's Head and Sandy Point. They even re-appear on the western side of the main river, near the County line between Saint John and King's, thus indicating that the whole of this great valley was once filled by them.

Between the rocks of the Kennebeckasis and those of Belleisle Bay, there is little diversity, except in the nature of the materials, and the source from which they have been derived. While the former, as before stated, consist mostly of fragments from the Portland Series, the latter are chiefly composed of the felspathic and horneblendic rocks of the Kingston Group. They are also finer in their texture, and hold a few thin beds of soft green and reddish shale. These rocks occupy a large area, and are well exposed, with beds of freestone, south of Belleisle Point, where the main road from Kingston crosses their broad flat surfaces, dipping slightly to the north.

They occupy also the entire valley of the Belleisle River, rising nearly to the summit of Bull Moose Hill, and thence extend to the eastward, along the slopes of the older series, as far as Butternut Ridge. The latter is composed of conglomerates with thick beds of limestone, and is continuous with the series which surrounds the great central coal-field of the Province.

Between the valley of Belleisle Bay and River, and that of the Kennebeckasis, the rocks are mostly of the kind above described. In addition, however, to the ordinary beds of conglomerate, shale, and sandstone, there are also several beds of impure bituminous limestone. These are well exposed at Dickie Mountain, on the northern side, (where the calcareous beds hold lead and copper,) and westward, along "the middle-land" road to Kingston. These limestones rest directly upon the altered rocks of the older groups, and may be considered as representing, at this locality, the lowest beds of the Carboniferous Series.

It has been stated that the Kennebeckasis conglomerates have been traced to the eastward as far as Apohaqui Station, near Sussex. Their outcrops, however, are not continuous, and at Norton they seem to be overlaid by a newer series, consisting of fine-grained grey sandstones, grey and black shales, with some thin beds of reddish calcareous conglomerates. These are well exposed in the railway-cutting east of the Station, and are remarkable for the great number and fine preservation of the ripple marks, and other impressions, on the softer beds. On one large slab, measuring four feet by four, no less than sixteen of these great ripples were counted, each occupying a space of from one to two inches.

At Apohaqui the lower deposits again appear, as well as the upper. The latter were found by Mr. C. R. Matthew to contain beds of bituminous shale, and sandstones with veins of *Albertite*.

It would be impossible, without unduly extending the limits of this Report, to give a detailed account of all the different localities included in the immense district now under consideration. At hundreds of points the Subcarboniferous rocks have been seen and studied by our party, but few facts, requiring special notice here, were observed.

Mr. Matthew has suggested the division of the series into two members, an upper and a lower, approximately equivalent to a similar subdivision of the same series in Nova Scotia. These two members are thus characterized:—

"1. A lower—consisting of coarse red conglomerates, red sandstones, and red shales. Fossils—Algae, and stems of land plants.

"2. An upper—comprising grey sandstones, and grey and brown shales."

To these divisions of Mr. Matthew, it is now necessary to add the occurrence of large beds of limestone and gypsum, as well as salt springs, in connection with the first member above given, or it may be, occupying even a lower horizon, and calcareo-bituminous shales associated with the latter. As these, however, are of economic importance, their consideration is deferred to the section on the useful minerals of the group.

In general, the coarser conglomerates of the lower division are most frequent along the southern margin of the basin, and near the older metamorphic hills, as at Damascus, through much of Upham, Picadilly Mountain, &c.; the fine grey sandstones and shales usually occupy the central portion of the valley, (in the eastern part, though not in the west), and from Sussex seem to cover most of the district as far as the Petitcodiac.

2. *The Valley of the Petitcodiac, between Moncton and Shepody Bay.*—The Subcarboniferous Basin of Albert and Westmorland Counties, continuous with that of the Kennebeckasis on its northern side, is irregularly bounded on the south and west by the metamorphic hills of the Devonian Series. Besides spreading widely over a continuous district, along either shore of the Petitcodiac River, the rocks of this division also partly occupy depressions between the folds of the older series, and gradually disappear among them. As the district is a large one, allusion will be made only to its more important features.

In the formations of the Albert County Valleys, rocks of both the divisions before enumerated are not uncommon. The coarser conglomerates of the lower member are usually found resting directly upon the metamorphic groups below them, and like those of the Kennebeckasis, have derived the great bulk of their materials from these groups. This is especially the case along the Pollet River, near Elgin, where the conglomerate is very coarse, and holds pebbles (some of them 30 x 18 inches in size,) of porphyry, syenite, jasper, protogine, red clay slate, quartzite, epidote, &c. All of these may have been derived from the rocks of the Cordaite Shales, and beds similar to many of them may be seen *in situ*, a short distance above. This is especially true of the porphyry, found penetrating the rocks in numerous dykes, and occurring in the conglomerates as pebbles of great beauty.

These coarser beds are but the eastern prolongation of the similar ones already noticed as common along the line of the Hammond River, and, though not perfectly continuous, re-appear at many points in the Parishes of Hillsborough and Hopewell. As already observed in the remarks on the older series, they progressively cover the latter to the eastward, and finally, at Shepody Mountain, rise above them. In the eastern and central, as in the western portion of the district, they are associated with sandstones and shales, with large and valuable deposits of limestone and gypsum. The precise localities of the latter will be indicated in the remarks on the useful minerals.

Irregularly distributed among the beds above described, are found, not unfrequently, the grey sandstones and shales which constitute the upper member, and at times also, deposits which can with difficulty be distinguished from the ordinary strata of the Coal Measures. But the formations which are most remarkable in the Group before us, and which give to the whole Series its most interesting character, are those to which we have already alluded under the name of *bituminous shales*, including the coal-bearing

beds of the Albert Mines, and the oil-producing strata of Baltimore, as well as those which yield petroleum at Hillsborough and Dover.

In the Acadian Geology of Dr. Dawson, (Chapter x,) there is given a section illustrating the relations of the Subcarboniferous rocks of Nova Scotia to those of New Brunswick, and also a detailed account of the geology of the Albert Mine, with a discussion of the origin and nature of that celebrated deposit. As this work is easily accessible, we do not here propose to enter into a recapitulation of the interesting conclusions therein contained, but only to add a few results of our own observations, upon particular localities in the neighbourhood. These will be more readily understood by reference to the following Table, constructed by Dr. Dawson, and designed to illustrate the succession of deposits, in descending order, between the mouth of the Petitcodiac River and the Albert Mines:—

"1. Grey sandstone, often coarse and pebbly, with shales and conglomerate, Hopewell Ferry, &c. These beds perhaps correspond to the great sandstone ledges of Seaman's Quarries, Joggins.

2. Reddish sandstones and shales.

3. Limestone and gypsum.

4. Red sandstone and conglomerate.

5. Grey and dark coloured conglomerate.

6. Calcareo-bituminous shales of the Albert Mines, Hillsborough. These beds appear here to lie at the very base of the lower carboniferous series." A similar descending succession was also observed to the northward, up the Memramcook River.

To these observations of Dr. Dawson, we would add the following remarks:—

A reference to the Geological Map, at the close of this Report, will show that the Albert Mines occupy a position nearly mid-way between the older metamorphic hills and the Petitcodiac River. These hills, constituting the high table-land of Caledonia, and its eastern spur, Shepody Mountain, have been shown to be probably a portion of the Cordaite Shales of the Upper Devonian Series, penetrated by, or at least containing, large beds of granite and syenite, near their central parts. On the northern side of this metamorphic range, in the settlement of Caledonia, shales of the same age and general character, but more highly charged with bitumen than those of the mines, appear, and seem to be in direct contact with the older beds. They here have an easterly strike, and a northerly dip of about 50°.

A few miles west of Caledonia, near the sources of the Prosser Brook, we have already pointed out the occurrence of bituminous shales, similar to the above, and recognizable by their peculiar fossils. This deposit is in the exact direction of a line connecting the shales of the mines with those of Caledonia, and indicates an extension of the series along the valley already alluded to between the sources of this stream and the Coverdale River. On the northern side, however, of the chain which separates this valley from that of the Petitcodiac, we have again the calcareo-bituminous shales, with their characteristic fossils, (extending westward through Elgin far into the County of King's,) but here no longer resting upon the metamorphic hills,

being separated from the latter by the thick and coarse conglomerates of the Pollet River.

At the last named locality the distribution of the series, which was carefully studied by Mr. Hartt and myself, is nearly as follows, the succession being an ascending one :—

1st. Metamorphic rocks of the Upper (Pollet River) Falls.

2nd. At the Lower Falls—Coarse conglomerates derived from the above.

3rd. Interstratified conglomerates, and hard grey sandstones. (Str. N. 48–50° E. Dip 60° N. W.)

4th. Grey sandstones and sandy shales.

5th. Bituminous shales—concretionary, and slightly calcareous—containing ganoidal scales. They more nearly resemble the shales of the Albert Mines than those of Caledonia. The strike and dip are irregular, but approximately as follows :—Str. N.—N. 44° E. Dip often vertical, but at times about 60° N.W. At some points a conglomerate is bedded in the shale.

6th. Grey sandstones, grits and shales—occupying most of the country between Elgin and Salisbury.

It would seem from these observations that the bituminous shales, though apparently in direct contact with the older series at Baltimore and Prosser Brook, are separated from the latter by conglomerates of great thickness at Elgin Corner, (and the same is true at other points,) these conglomerates, therefore, constituting a lower member. Whether the similar deposits of the Kennebeckasis occupy the same position, is not certainly known; but the relation of the bituminous shales near Norton, evidently a westward prolongation of those at Elgin, to the beds below them, render it probable that such is the case. This view is still further confirmed by the observations made upon the carboniferous districts of the coast, where the coarse conglomerates seem to occupy a similar position.

3. *Coastal Detached Areas.*—The principal localities along the Bay of Fundy, at which Carboniferous deposits have been observed, have been already enumerated. At some of these localities, beds of the Lower Coal Measures, as well as those of the Subcarboniferous Series, occur, and for convenience will be considered in connection.

a. Gardner's Creek and the Region around Quaco.*—"The Carboniferous rocks of Gardner's Creek and vicinity, form a part of the largest of several deposits of this æra, scattered along the southeastern shore of the Province, east of Saint John; now isolated, but evidently marking the former existence of a large area of sediments in the depression filled by the waters of the Bay of Fundy, continuous with the coal formation which bounds its northeastern end; and probably connected also with the Lower Carboniferous (Dawson) of the Kennebeckasis valley, by the depression of land at the mouth of the Saint John River.

"The strata of the district under consideration seem to lie in a series of undulations, nearly parallel to those of the older series of metamorphic

*The following description of the first-named locality is written by Mr. Matthew, from data collected by that gentleman and myself, while spending a few days in that vicinity in the Summer of 1862.

rocks, but having frequently a more northerly direction. These corrugations have been impressed upon the beds, at some period between the close of the Carboniferous and the Triassic epoch; since, as will be shown in the sequel, sediments of the latter age were found reposing upon the upturned edges of the Carboniferous beds.

"Along the shore, from Emerson's Creek to Quaco, cliffs of greater or less elevation, present excellent opportunities for studying the varied characters presented by these latter. The strata consist chiefly of sandstones and shales, in frequently alternating beds, varying from a few inches to 20 feet or more in thickness. The prevailing colour is a chocolate red, paler, and often giving place to grey, in the sandstones, but frequently deepening to a dark purplish red in the shales. The sandstones often pass into grit, and more rarely into beds of a hard conglomerate, made up of pebbles derived from the indurated rocks of the metamorphic hills, imbedded in a sandy matrix.

"A few beds of dark grey shale occur, and, with the finer sandstones, hold plants of several genera and species characteristic of the true Carboniferous formation, usually in an imperfect state of preservation and by no means abundant.

"Specimens of these fossils were submitted for examination to Dr. Dawson, who remarks upon them as follows:—

'In looking over your Gardner's Creek plants, I find the following:—

Cordaites borassifolia, and *trunk* of same.
Calamites Suckowii.
C. —— cannaeformis.
Megaphyton, (species not determinable.)
Sternbergia.
Cardiocarpon, (several species.)
Lepidophyllum.
Neuropteris, { like N. Loshii, / like N. auriculata, } too imperfect to be sure of them.

'In so far as they tell anything, (and this is not very much,) the specimens are Carboniferous rather than Devonian, and are more like the *Millstone Grit* than any other part of the Carboniferous.

'I had almost forgotten to say that the *silicified wood* seems to be coniferous, and *may* be *Dadoxylon Materiarium*, but is not well enough preserved to be certainly determined.'

"Westward of Wallace's Cove, massive beds of a hard conglomerate (of grey and brown colours), derived from the wreck of the Devonian and Silurian rock northward, are brought up by an anticlinal fold in the formation, and constitute the principal mass of the bold promontory known as M'Kay's Head.

"A similar deposit may be seen at Quaco and Rogers' Heads, resting on the flanks of ridges of intrusive trap. Near the Light House at Quaco, it is associated with thick beds of limestone, and for the reasons to be stated presently, Prof. Bailey and myself think both it and the calcareous strata, Lower Carboniferous, the conglomerate probably representing the coarse fragmentary rocks of the Kennebeckasis valley.

"As already intimated, the strata of this coal basin are much folded and otherwise disturbed. Faults, connected with downthrows, were observed at several places; and at Dewar's, (Gardner's Creek,) where the beds are curiously folded and bent, an admirable opportunity is afforded, both in the cliff and on the beach, for studying these phenomena. There seems to be an extensive overturned dip at this place, as indicated in the Sketch and Diagonal Section * across the measures, by which the higher members are inverted."

The region about Quaco, above alluded to in the remarks of Mr. Matthew, is a very complicated one, and deserving of further notice. Subcarboniferous, Carboniferous, New Red Sandstone, and Eruptive Rocks, are all present, and so intimately associated as to be difficult of recognition. The general relation of these different groups will be apparent from the Section (H) illustrative of this locality, and from the following descriptive notes:—

The village of Quaco is situated partly on Carboniferous and partly on Triassic and Diluvial beds. To the west of the settlement, and on either side of the Light House, rise the two bold promontories of eruptive trap, known as Quaco Head and Rogers' Head, the latter attaining an elevation of over 200 feet. Reposing upon the flanks of the first mentioned ridge, the lowest beds observed are limestones (without fossils), attaining at times a thickness of 25 feet, and covered by a hard and coarse conglomerate, composed of materials derived from the eruptive and calcareous beds below, with some pebbles of manganesian slates, cemented by a fine red sandy paste. These conglomerates are undoubtedly the equivalents of those forming the promontory of M'Kay's Head, and of others which occur to the eastward, and like them are covered with thick beds of grey conglomerate and sandstone, (holding *Calamites* and trunks of trees,) with some thin beds of calcareous shale, (the latter containing *Cyprides*, *Naiadites*, *&c.*). All the beds above referred to are full of faults, displacements, and downthrows, a few of which are indicated in the Section. It is in these faults, and among the beds which bound them, that the principal deposits of manganese, formerly mined, occur.

Overlying all the rocks above named, and irregularly filling in all the inequalities produced by the igneous disturbances, are deposits undoubtedly referable to the Triassic Period. The lowest of these deposits, occurring near Quaco Head, and in the rear of the Light House, is a bright red calcareous breccia, holding interstratified beds of manganese. It is unconformable to the underlying strata, being evidently composed in part of materials derived therefrom, and is covered *conformably* by beds of New Red Sandstone, which appear at the Light, and also to the eastward, overlying the trap of the Head, as well as on the shore forming both sides of the Harbour.

In the succession of deposits above enumerated, a number of distinct events are indicated; first, the denudation of some older metamorphic Series,

* See Sections (D and G) at close of the Report.

(probably the Cordaite Shales,) and the production therefrom of the hard conglomerates, associated with thick beds of limestone, which represent the base of the Lower Carboniferous Series; secondly, a slow succession of oscillations near the sea level, of low land growing *Calamites* and trees, and giving rise to the thick beds of sandstone, conglomerate, and shale, with thin seams of coal; thirdly, an upheaval of the trap, causing violent dislocations of the overlying beds, and an alteration of the limestone; and lastly, a period of repose, in which the calcareous breccia and red sandstone strata were deposited in regular succession upon the upturned beds below them. If we take into account the fact that manganese occurs in the superficial deposits of drift, this metal would seem to have belonged successively to no less than *five* distinct geological Periods.

b. Martin's Head, Goose Creek, Point Wolf, and Salmon River.—The remaining coastal Carboniferous areas require but brief notice. At the first of the above named localities, deposits of this age may be seen, filling the space between the Head and the high metamorphic series in the rear. They consist of soft grey sandstones, friable marls and shales, of pale brown, grey, and chocolate colours, and differ from the ordinary type of the coastal Series in their remarkable softness and incoherence. They form a synclinal between the extremity of the Head and the upland, reposing unconformably upon the rocks of the latter, with a southerly dip of 60°. They here hold beds and veins of gypsum, and are overlaid by several well defined marine terraces.

A short distance to the eastward of the last named locality, red and purple conglomerates, and grey slaty calciferous shales are exposed in nearly perpendicular beds, and form the eastern side of the Harbour of Goose Creek. They probably represent the similar beds at M'Kay's Head and Quaco, and afford fine crystals of calc-spar in several varieties.

At Point Wolf, the hard conglomerates representing the base of the Series again appear, but constitute only a few small Islands. Between the latter and the high hills of the metamorphic shore belt, softer conglomerates and sandstones, of red and chocolate colours, are seen dipping northerly, and form the inlet of Herring Cove. They are here covered with thick beds of grey and buff coloured sandstones and shales, shattered and broken in every direction, and filled with enormous pot-holes. It is probable that the lower beds, dipping below the hills, have contained limestone or gypsum like the similar beds at Martin's Head, which, being undermined by the sea, have caused the falling in of the immense superincumbent mass. It is difficult in any other way to explain the broken character of the ground, which in roughness is unequalled in this portion of the Province. As a confirmation of this supposition, I may add that a salt spring issues from the hill upon the Bay Shore.

The Carboniferous Beds of Point Wolf extend to the eastward, through the settlement of Salmon River, and thence to Salisbury Cove. Between the two last named localities, however, the hard conglomerates at the base

of the series again appear, and rise into the bold ridge known as Owl's Head, attaining an elevation of not less than seven hundred feet. They are exceedingly hard, containing pebbles of *quartz*, *epidote*, *jasper*, *calc spar*, *talcose slate*, &c., derived from older series, and are filled with slickenside surfaces. Resting upon them, and forming the northern side of the ridge, are fine-grained grey sandstones and thin conglomerates, the former holding remains of *Sternbergia*, *Calamites*, *Lepidodendra?* *Sigillariae*, *Megaphyta*, &c., with large trunks of undetermined trees. The sandstones at this locality, as also at Quaco, contain numerous thin seams of *coal*, the bituminized remains of the coal-plants; and attempts have been made to open mines for this substance, but with little or no prospect of success.

Between Salisbury Cove and Hillsborough, the deposits are chiefly those of the upper member above described. Some ridges, however, of conglomerate appear, and constitute the promontory of Cape Enragé, as well as the long islands lying between the latter and Shepody River.

That the deposits of the coastal Carboniferous areas above described contain beds of the Subcarboniferous Series, as well as of the Lower Coal Measures, is regarded as probable by both Mr. Matthew and myself, for the following reasons:—

1st. Heavy beds of hard and coarse conglomerates, such as are seen at M'Kay's Head, Quaco Head, Goose Creek, Point Wolf, and Owl's Head, do not occur in the great central coal basin of the Province, (though this may be due to the absence of protruding ridges, from which these conglomerates might be derived); they probably represent the coarse fragmentary beds of the Kennebeckasis Valley.

2nd. The existence of thick beds of limestone, such as that of Quaco (and Salmon River?). These limestones occupy the same relative position as those of Sussex and Upham.

3rd. The occurrence of *gypsum* at Martin's Head, Salmon River (?), Cape Enragé, and Hopewell; and

4th. The apparent connection of the conglomerates at Owl's Head, with the Lower Carboniferous of Shepody. The finer beds at the same locality, and also west of Quaco, may represent the Millstone Grit of Dawson.

4.—*The border of the great central Carboniferous Basin.*—This division of the Series is a very extensive and varied one, occurring as a narrow belt skirting the Coal Measures around their entire extent.

Starting from the north side of Butternut Ridge, where they gradually coincide with the Series already described of the Belleisle and Sussex Valleys, these rocks may be traced to the westward, along the northern flanks of the Kingston Group, as far as the Saint John River, at Long Island. Crossing the latter, (being nearly opposite on the two sides, not widely separated as heretofore represented,) they extend in a nearly uniform southeasterly direction through the settlement of Inniskillen, to the road between Saint Andrews and Fredericton, south of Brockaway's. Here gradually bending

around, they assume at first a northerly, and then a northeasterly direction and in the latter course extend, with some irregularity, as far as the Coast of the Bay Chaleur, near Bathurst. The belt is but the outcropping border of a Series, which probably underlies the greater portion of the Carboniferous basin.

Of the extensive district implied in the above description, I have personally examined bnt a very small fraction. These examinations, however, have been found to possess so many features in common, that the general character of the series is sufficiently established. The latter may be conveniently divided into two Sections, based rather upon the conditions of their origin than their geological relation.

1st. A volcanic series,—the rocks being yellow and reddish-purple quartzose grits and altered slates, associated with thick beds of trap, basalt, and amygdaloid, and altered by them.

2nd. Red calcareous conglomerates, red sandstones, and red shales, (unaltered.)

A. Hampstead and Rush Hill, Queen's County.—A general description of the distribution of the different formations at the first of these localities, has already been given in the remarks on the great central granitic band of the Nerepis. In advancing to the north from this granitic axis, after passing a moderately wide belt of nearly vertical mica schists, the latter abruptly give way to a wide-spread series of volcanic and altered rocks, evidently referable to the Subcarboniferous Period. They occupy an area of several miles along the western side of the River, opposite Long Island, and extend to within a short distance of the Otnabog Lake, where they become covered with the ordinary grey rocks of the Coal Measures. It is near their junction with the latter that the best and most typical exposures may be seen, as given in the following Table, the succession being a descending one :—

1. South shore of Otnabog Lake—Grey sandstones, in broad, flat masses, with very slight northerly dip.

2. (At the farm of Mr. Merritt, one mile below)—Basaltic and vesicular trap, with coarse-grey amygdaloid, holding *calc spar*, *quartz*, and *heulandite*. The trap slopes gradually to the north, but on the south presents a bold mural face, the general direction of which is N. 60° E. In the valley thus formed are met—

3. At the foot of the cliffs—Buff coloured Carboniferous sandstones.—Dip 40° N.

4. Soft, ochreous, blue and yellow shale, with splintery fracture.

5. (Immediately below the latter)—30 feet of greyish and reddish semi-crystalline limestone, holding numerous fossils.

6. Thick beds of yellowish and reddish altered grit, projecting in pseudo-columnar masses. This is the most abundant and the most remarkable rock of the series. It is of a coarse though uniform texture, and consists of bright glassy particles of sand, perfectly transparent, imbedded in a reddish or yellowish clayey paste. It is quite hard and compact, at times recalling porphyry, but is destitute of a distinctly crystalline character. It passes also insensibly into other beds, which approach more nearly to an ordinary grit. These, with the rocks first mentioned, probably underlie most of the district between Merritt's and the slate of Hampstead, but are largely concealed by diluvial detritus. Many volcanic beds, however, appear, consisting of hard conchoidal basalt, vesicular trap, and amygdaloid.

Directly opposite the section above described, and occupying an equal, if not a greater area, the same series again appears in the Parish of Wickham, the same curiously altered grits being exposed, in broad flat masses, along the river side for several miles. The trap ranges, however, though present, are much less numerous and prominent, while the finer beds and limestones are not immediately apparent. The latter, however, may again be seen a few miles eastward of the river, at Rush Hill, where they resemble in every respect those of Hampstead, in character as well as in the fossils which they hold. They also resemble the limestones of Butternut Ridge, and between the two may be observed at many points along the northern slope of the high land which forms the water-shed between the Washademoak and Belleisle. There is, however, this important difference in the geological position of the series on the two sides of the Saint John River; while on the western these Subcarboniferous rocks repose against vertical mica slates, on the eastern the underlying beds are of the Kingston Group. The nearest rock observed in the neighbourhood of the limestones at Rush Hill, was a coarse-grained diorite, similar in every way to those so abundant in the formations north of the Belleisle.

B. Bald Mountain, York County.—About twenty miles west of Fredericton, and a little to the north of the Saint Andrews Road, near where the latter enters the Harvey Settlement, rises a hill, sloping gradually on its eastern side, but on the western laid bare in a bold mural cliff, known in the neighbourhood by the name of Bald Mountain. This hill, a prominent object in the landscape for miles around, is as curious in its characters and probable origin, as in the isolated position which it holds.

In approaching the eminence from the south, the only rocks observed in the immediate neighbourhood were grey sandstones, &c., similar to those of the central carboniferous district. A short distance to the eastward, however, near the sources of Long's Creek, ledges of red calcareous slaty conglomerate may be seen, dipping westerly, and again at various points in the settlement of Harvey. It would thus appear that Bald Mountain, like the trap beds of Hampstead, occupies a position near the line of junction between the Subcarboniferous Series and the ordinary Coal Measures.

This analogy of relation, taken in connection with the bold and precipitous character of the eminence, would at first sight suggest an eruptive origin, and lead us to expect the presence of basalts and amygdaloids, similar to those so extensively and prominently exposed in the County of Queen's. An examination of the hill itself, however, shows the presence of no such rocks, being entirely composed of sedimentary beds, extremely altered.

These sedimentary rocks may be classified as follows:—

1. Altered purplish slate or claystone, partly amygdaloidal.

2. Dark purple compact felspar, porphyritic with limpid particles of quartz.

3. Altered volcanic grit, also with limpid pebbles of quartz, and undistinguishable from the similar beds of Hampstead and Rush Hill.

The principal mass of the mountain is composed of the altered rock constituting the first of the above divisions. No distinct stratification is apparent, the whole series displaying marks of violent distortion. Many of the rocks exhibit on their weathered surface innumerable zigzag furrows, running in all directions, and giving to the mass the appearance of having been violently compressed while in a still flexible condition; while others are perfectly compact and of extreme hardness.

Neither the second nor the third of the above named divisions were found *in situ* upon the summit of the mountain, but are well exposed on the western flank, and along the Saint Andrews Road, to within a short distance of Harvey. In the latter place, the unaltered red slaty conglomerates appear, and occupy an extensive area.

The details of the two localities above given will suffice as descriptive of a group of rocks largely developed in connection with this division of the Subcarboniferous Series, and which re-appears at many points along the borders of the great central basin. Among other marked localities, I may allude to the district a few miles west of Fredericton, where, on both sides of the Saint John River, we have a re-occurrence of the volcanic beds, in connection with the red sandstones and reddish purple conglomerates, of this formation. The latter may be seen at the Indian Village, resting upon contorted Silurian (?) slates, and again at Sugar Island, in the Saint John River, where they are gypsiferous, and underlie silicious conglomerates, dipping southwesterly at an angle of 90°. At these localities, however, the sedimentary beds are destitute of the highly metamorphic character so remarkable in the rocks of Bald Mountain and Hampstead, while the trappean beds are more basaltic. The latter are well exposed along the river-edge of the Keswick Ridge, and opposite the French and Indian Villages. They also re-appear at Spring Hill, and on the opposite side of the river, at Clark's Mountain and the Royal Road.

The following Table will be found to illustrate, in a systematic order, the various localities where observations have been made on the characters and distribution of this most important series, throughout its entire extent. They are partly the result of my own observations, and partly of those of Dr. Robb:—

a. Parish of Wickham, Rush Hill, &c., Queen's County, described above.

b. " Hampstead, Merritt's, &c., " " " "

c. Inniskillen Settlement, Petersville Parish, Queen's County. Porphyritic breccia.

d. "Brook of Sticks," near Vail's (Brockaway's)—road between Saint Andrews and Fredericton.—Light purple conglomerate, near porphyry, and under grey grits, dipping north. This porphyry is much like the altered slate of Bald Mountain.

e. Northwest end of Harvey Settlement, near Messiah Brook.—Porphyritic breccia, under grey grits.

f. Harvey Settlement, main road.—Red conglomerate, near porphyry.

g. Bald Mountain.—Altered slates and grits, described above.

h. On road from Bald Mountain to Long's Creek, at farm of Nicholas Barker.—Dull reddish brown slaty conglomerate.—Pebbles, angular fragments of trap and mica slate; cement, calcareous.

i. Saint John River, at French and Indian Villages.—Red sandstones and conglomerates, with basaltic trap.

j. Sugar Island and Keswick Ridge.—Same as above.

k. Clark's Mountain, Keswick Road. " "

l. M'Leod's Hill, Royal Road.—Vesicular trap and amygdaloid, much like that of Hampstead, exposing to the west a bold front, but sloping gradually to the east. The amygdaloid holds fine quartz crystals and rhombohedral calc spar, but no heulandite.

m. Between Cardigan and Stanley, York County; also, at Tay Creek and Red Rock Settlement.—Red sandstones, resting on metamorphic slates.

n. Three miles below Stanley.—Red marly sandstones, under grey grits, and near clay-stone porphyry; the latter light coloured, with dark purple blotches.

o. Four miles from Boiestown, forming the axis of the Portage between the Nashwaak and Miramichi.—Amygdaloid.

p. Mouth of the Nepisiquit River, near Bathurst.—Light blueish and reddish sandstones and conglomerates, with light blue shales, holding Lignite and Copper Ore.

It will thus be seen that throughout this extensive Series, the association of volcanic outbursts with red and purple sediments is very marked, and shows that the period of igneous activity, so prominent during the Devonian Age, had not yet ceased in the earlier part of the Carboniferous. It is probable that the greater portion of the references made by Dr. Gesner to eruptive rocks along the district occupied by this belt, as well as the similar indications in the geological Map of Dr. Robb, have had their origin in beds belonging to the Group now under consideration.

AGE.—It has already been stated in the Introductory Chapter, that the great series of sediments now described, were originally referred by Dr. Gesner to the New Red Sandstone or Saliferous System of European geologists, but subsequently, on account of its resemblance to similar formations in Nova Scotia, to the Lower Carboniferous Series. Dr. Robb, on the other hand, while supposing that most of these red beds were below the Coal Measures, and possibly Devonian, indicates by the colouring of his Map, that the grey rocks of King's, Albert, and Westmorland Counties, including the bituminous and coal-bearing strata of the Albert Mines, form a part of the same series as the grey sandstones and grits of the great central basin.

That all the beds included in the foregoing descriptions are, unless otherwise stated, properly to be referred to the Lower Carboniferous System of Dawson, is conclusively proved by the following facts:—

a. The stratigraphical relations of the Albert County rocks, already explained, show their position near the base of the Series referred to. This position is confirmed by the evidence of the fossils,* viz:—*Ganoid Fishes*, remains of *Lepidodendron elegans*; *L. corrugatum*, *Cyclopteris Acadica*, and stems of large ferns. These fossils, as well as the character of the beds which

*Observed by Messrs. G. F. and C. R. Matthew in the beds near Norton; also by Mr. Hartt at the Albert Mines, and Elgin.

hold them, render it probable, as first observed by Dr. Dawson, that the latter are contemporaneous with the similar beds of Horton Bluff, in Nova Scotia.

b. That the coarse fragmentary rocks of the Kennebeckasis Valley, and the detached coastal areas, are partly of the same series, but of a lower horizon, has already been shown by their position underneath the bituminous shales of Albert. Associated with the coastal areas, however, are some beds probably referable to the Millstone Grit, and others to the Lower Coal Measures.

c. The limestones, salt-springs, and gypsum, so abundant throughout the series, establish the identity of the latter with the similar Group in Nova Scotia.

d. The limestones referred to, where not too much altered, as at Hammond River, Norton, Butternut Ridge, Rush Hill, and Hampstead, contain characteristic Lower Carboniferous fossils, *Terebratulae, Producti, Conulariae, &c.*

Topographical Features.—Among all the geological formations represented in New Brunswick, there are probably none which exhibit such diversity of outline and position, as the rocks of the Subcarboniferous Series. Being composed of a great variety of material, conglomerates, sandstone, shale, limestones, and traps, and therefore very differently affected at different places by denuding and other agencies, the features of each particular district may in general be inferred from the prevailing character of its rocks.

As a rule, the land underlaid by members of this series is comparatively low, yet at times, when the coarser beds appear, hills and ridges of very considerable altitude are found. This is especially the case along the southern margin of the great central valleys of the Kennebeckasis and Petitcodiac, as well as among the isolated areas on the coast. Among the latter, the high conglomerate ridges of M'Kay's Head, Rogers' Head, Owl's Head, and Quaco, are unsurpassed in this portion of the Province for their lofty and rugged grandeur.

Between the ridges and valleys of the Carboniferous, and those of the underlying metamorphic series, there is always this distinction to be observed, that while in the latter the elevations and depressions are the results and indications of great flexures in the beds, the former indicate no disturbance whatever, being merely the result of excavation by running waters. The general course and dimensions of the older valleys are therefore uniform over extensive areas, while those which are due to the eroding power of water, are as irregular as the direction of the currents which produced them. Even where conforming to the general folds of the district, the latter are often connected by transverse valleys, the former never so, unless through the agency of faults, giving new direction to the currents.

Bearing in mind these facts, together with what has already been stated with regard to the character and distribution of the group, it will not be

difficult to understand the more prominent topographical features of the different districts occupied by these rocks.

The most important of these districts, both in an agricultural point of view, and as affording the only easily available line of connection between the eastern portion of the Province and the City and River of Saint John, is the great valley of the Kennebeckasis and Petitcodiac Rivers, sufficiently indicated by the position of the European and North American Railway, which occupies its centre. This valley is too well known to require minute description here.

South of the latter, and approximately parallel in general direction, are the valleys of the Hammond River and its tributary, the Salt Spring Brook. These valleys are bounded and separated from each other by high and frequently precipitous ridges of coarse conglomerate, due entirely to the action of running waters, which have removed the softer shales and sandstones, while the harder beds have been unaffected. These conglomerate ridges, so common in the Parish of Upham, continue to the eastward, where they include Picadilly Mountain and the high lands south of Sussex, and along the Dutch Valley, (being here divided by the transverse depressions of Trout Creek and its branches,) and extend far into the County of Albert. In the latter, however, the conglomerates gradually approach the older series, and conform to their foldings, while the country to the east and south, at and about the Albert Mines and Hillsborough, becomes broken into innumerable minor valleys, too irregular to admit of accurate description.

The only remaining district requiring notice in this connection, is the great border of the central Carboniferous basin, where the presence of eruptive agencies has produced features somewhat different from those found in other portions of the Series. As a whole, this belt of rocks is low, (although more elevated than the beds of the Coal Measures which it surrounds), and only acquires prominence where raised and altered by igneous dykes, as at Bald Mountain, Keswick Ridge, and many other localities.

Agricultural Capabilities.—While, as has been shown, the districts occupied by the rocks of the Silurian and Devonian ages are for the most part covered by soils of a poor, or very inferior quality, those in which the series now under consideration occurs, are unsurpassed for their value and fertility. Composed for the most part of materials very imperfectly consolidated, they are easily acted upon by atmospheric and aqueous agencies, and readily crumble into rich and productive soils. The presence also of limestone and gypsum, of almost universal distribution through the series, greatly enhances its value, and gives to this division of the geological scale an interest which is scarcely equalled even by its abundant mineral deposits. Hence the great importance of an accurate knowledge as to the distribution and characters of its several members, and of a Map by which their location may be readily ascertained. No other district in the Province, except where alluvial deposits prevail, will compare with that of the Subcarbon-

iferous Series in fertility, and none, therefore, offers so many facilities for settlement. In the southern portion of the Province, this fact, readily recognized by settlers, though unconscious of its cause, has led to the occupation of the greater part of the district, but many fertile tracts still remain uncleared; while along the Tobique River, where similar rocks occur, the advantages of settlement are unsurpassed. The position of these rocks, so far as they occur in the southern Counties, may be readily ascertained from their delineation on the Map. Where limestone and gypsum are indicated, the soil can hardly fail to be of a rich and productive character.

USEFUL MINERALS.—The deposits of economical value belonging to the Subcarboniferous Series, are *Limestones*, *Gypsum*, *Salt*, *Coal*, *Bituminous Shale* and *Petroleum*, *Freestones*, and the ores of *Iron*, *Lead*, and *Manganese*.

a. Limestone, Salt, and Gypsum.—The mode of occurrence of these three most valuable minerals has already been described in the remarks on the characters of the Series. It only remains to indicate in tabular form the various localities in which they have been found.

LIST OF LOCALITIES CONTAINING SUBCARBONIFEROUS LIMESTONES, SALT SPRINGS, AND GYPSUM.

ALBERT COUNTY.

Demoiselle Brook.—Limestone, gypsiferous sandstone, and gypsum.

Plaster Quarries.—The beds, as observed at this locality by Mr. Hartt, are 60 feet thick. The gypsum is of two varieties, the *Hydrous* and the *Anhydrous* Sulphate, which pass into each other. The latter is usually of a blueish tint and is much seamed by "soft plaster." It also occurs of a very pure white colour, and quite translucent. The *Hydrous* variety is often equally white, and so soft as to be readily cut with a knife. Reddish brown crystals of *selenite* were observed to occur rarely in the plaster. The latter, with slaty limestone, may be seen outcropping at many points in the neighbourhood. At the time of our visit, extensive operations were in progress, 80 tons being daily transported to the wharf on the Petitcodiac River.

Near Elgin.—Limestone, on farms of James Ayton, and J. Hayward.

Prosser Brook.—Limestone, on farm of Isaiah Steves.

Turtle Creek.—Limestone, on farms of Edward Berry and William Forbes.

KING'S COUNTY.

Butternut Ridge.—Limestone and Gypsum. (Salt Spring, Gesner.)

Hammond River, Parish of Upham.—On road from Quaco to Sussex, at W. Baird's, large bed of gypsum. To the eastward, near Wanamake's Inn, limestone.

Davidson's Manganese Mine.—Limestone;—also at the source of South Branch of Trout Creek.

Mill Stream.—Limestone and Gypsum, at several points between Apohaqui and Butternut Ridge.

Norton.—Limestone, with galena and copper pyrites.

Salt Spring Brook.—Salt Springs, on land of A. Campbell.

Sussex.—Limestone, gypsum, and salt springs.

Springfield.—On middle-land road from Kingston to Belleisle, Limestone.

QUEEN'S COUNTY.

At Merritt's, above Hampstead, limestone.

Rush Hill.—Limestone; a continuation of the same is indicated by boulders along the northern side of the high land in rear of the Belleisle.

SAINT JOHN COUNTY.

Quaco.—Thick beds of limestone, between the Village and Rogers' Head.

Martin's Head.—Gypsum. This deposit was formerly worked, but long since abandoned, except as required for local use.

WESTMORLAND COUNTY.

Parish of Salisbury, on the North River, above Petitcodiac Station.—Limestone, Salt Spring, and Gypsum.

Parish of Sackville.—Gypsum.

To the above may be added the immense limestone and plaster beds of the Tobique River, already noticed as probably referable to the Subcarboniferous Series.

b. Coal and Bituminous Shale.—The only deposits belonging to the Subcarboniferous Series, usually referred to the above head, are the so-called coals of the Albert Mines, near Hillsborough, and the calcareo-bituminous shales or cannel coal of Baltimore. We do not propose here to enter into the vexed question as to the nature and origin of the first named substance, but refer the reader to the Acadian Geology of Dr. Dawson, where will be found a complete history of the remarkable locality in which it occurs, with observations on its character and probable mode of formation.

We may, however, state that, in the opinion both of Mr. Matthew and myself, the Albertite is neither *coal* nor *jet*, but an *oxydized oil*, derived from the decomposition of fish remains, and subsequently changed by chemical action. We base this opinion partly on its geological age, (the discovery by Mr. Hartt, during the past summer, of *Cyclopteris Acadica* and *Lepidodendron elegans* in the shale of the Mines, proving its position as a part of the Lower Carboniferous of Dawson, probably equivalent to the red shales of Gaspereau, Nova Scotia,); partly on the almost complete absence of vegetable remains and underclays, such as abound where all true coal-beds exist; partly on the chemical composition of the substance, and the almost entire non-production of ash, when burned; partly also on its perfectly homogeneous character, wherein it differs from all ordinary varieties of coal; and lastly, upon the mode of occurrence of the deposit itself, which is not like that of a true *bed*, but rather in *veins*, irregularly penetrating not only the enclosing shale, but also layers of sandstone at a great distance from the principal deposit. To these reasons may also be added the fact, that springs containing oil are not uncommon throughout the district in which the Albertite is found.

A more important question than the origin of this coal is that of its *amount*, and the probability or otherwise of its occurrence in different localities from those now under exploration. The determination of this question, however, is beset with many difficulties, due partly to the unsettled state of the country, but chiefly to the very irregular mode of occurrence in the deposit itself. Our labours have been mainly devoted to ascertaining the geographical extent and distribution of the accompanying shales, and their relations to other groups.

Before leaving the vicinity of the original Albert Mines, it may be well to refer to a more recent attempt to obtain this coal, from another locality in the immediate neighbourhood. At a point about half a mile from the principal works, and near the line of the Railway, a shaft* has been sunk to a depth of 200 feet. It passes through a very friable dark red sandstone, with greenish patches, in which also fibrous gypsum occurs abundantly, filling up the cracks and joints. The bituminous shales may be seen at several points near the works, being much folded and full of concretions. Their strike is irregular, and the dip, while at one point only 4° or 5° to N. 55° W. is at another southerly to about the same amount. The coal does not apparently differ from that of the Albert Mines, but I am not informed as to its quantity or mode of occurrence.

In the remarks on the characters of the Subcarboniferous Series, it has been stated that the calcareo-bituminous shales occur at several points to the westward of the original Mines, as at Baltimore, Prosser Brook, and Elgin. It would seem, (as will be apparent from an examination of the Map,) that there are two or more distinct bands of this substance, extending in nearly parallel directions, over a large extent of country.

The first of these belts may be considered as having its centre at the Albert Mines. About six miles to the westward occur the so-called shales or pyro-schists of Baltimore, evidently co-ordinate with those of the former locality, though differing somewhat in appearance and composition. Like the latter, they contain Ganoidal fishes and veins of Albertite, irregularly distributed through the mass of the rock. Still advancing westward in the same direction, we reach the head of Prosser Brook, where again the peculiar bituminous shale may be seen near the house of A. Hayward, and is easily recognizable by its peculiar fossils. It here occupies a position at the bottom of a narrow valley in the older metamorphic series, and apparently rests upon the latter. Beyond this point it has not been traced in this direction.

The second belt, occupying a position somewhat north of the latter, extends along the base of the metamorphic hills, and was first observed a few miles east of Elgin, on the land of W. A. Colpitt. It was found at this point to be highly bituminous, and several fossils were detected by Mr. Hartt, among others, the common *ganoid scales*, teeth of a *rhizodont* type, like those of Horton Bluff, in Nova Scotia, and remains of plant-stems, with a fragment of *Lepidodendron elegans*. With the shales occur friable grey calcareous sandstones, and thin layers of fibrous calc spar. The former have a strike about N. 45°—50° E., and a northerly dip of 50°.

In the village of Elgin the bituminous shales again appear, and were traced in a westerly direction for some distance up the branch of the Pollet River. They more nearly resemble the shales of the Albert Mines than those of Baltimore, are often highly calcareous, and contain, besides some obscure fern-stems, numerous large plates of fishes, much like those of Horton Bluff. The general relations of the beds at this locality have already been given.

To the westward of Elgin, and in the eastern part of the Parish of Sussex, a shaft has been sunk in beds of shale, evidently a continuation of those last described, and *Albertite*, in every way similar to that of the first discovered deposit, has been sparingly removed.

* The observations at this locality were made by Mr. Hartt. Since writing the above, I have received a specimen, termed "East Albert Coal," recently discovered about two miles southwest of Hillsborough. It does not, apparently, differ from the ordinary Albertite, and gives new interest to the occurrence of this valuable mineral. The new vein at the surface has, I believe, a thickness of three or four inches, which increases with the depth.

The next point at which deposits of the substance under consideration have been observed, is at Morris', on the South Branch of Trout Creek, and still in the general direction of the deposits already described.

Lastly, calcareo-bituminous shales, as before noticed, occur in the vicinity of Norton, with sandstones, containing veins of Albertite. This is the most extreme westerly point at which beds of this character have been observed.

Returning to our starting point, at the Albert Mines, and going in an easterly direction, the fish bearing shales are again found on the eastern side of the Petitcodiac, in the County of Westmorland, but whether a continuation of either of the above described belts, it is difficult to say. The following are points at which they have been observed:—

a. Boudrot's Village, Parish of Dorchester. This is in the exact direction of a line connecting Baltimore and Hillsborough.

b. At White's, near the Ferry, Dorchester.

c. At J. Robertson's, Memramcook.

d. Near Ayer's Mill, Dover.

It will thus be seen that of the two belts of coal-bearing shale, the one occupies a position somewhat to the north of the other, and extends with much regularity from Norton Station through Elgin to Dover. The second, approximately parallel, also extends easterly from Prosser Brook through Hillsborough, to the Memramcook River, in Dorchester.

While thus succeeding, beyond our expectations, in the determination of the position and extent of the Albert Shales, we are still without definite facts as to the actual occurrence of workable deposits. When, however, we consider the comparatively slight indications which led to the exploration of the original mine, we may well trust that in a district so large, other beds of equal extent and value will be found. The presence of the mineral itself at such widely separated points, the abundance of fish remains wherever the shale occurs, and the highly bituminous character of the latter, to say nothing of the presence of oil-springs, all tend to confirm this opinion, and to give to this portion of the Province an interest not exceeded by any other.

Petroleum.—In connection with the discussion of the characters and position of the Albert coal, and the oil-yielding strata of Baltimore, it is interesting here to allude to the various points at which the last named substance has been found to exist as a naturally-formed product.

The presence of *petroleum*, or mineral oil, in the Parish of Dorchester, was early recognized by Dr. Robb, Dr. Jackson, and others, but it is only within the last few years that any attempts have been made to open distinct wells. The principal locality at which operations have been begun, is that where the presence of this substance was earliest pointed out, viz: the district lying between the Petitcodiac and Memramcook River, near Dover. The "Westmorland Petroleum Company," incorporated in 1864, have here erected buildings suitable for their undertaking, and have sunk by boring to a depth of over 400 feet. The rocks passed through, as enumerated in a Report to the Company, are as follow, in descending order;—

Blue clay.
Shale.
Soapstone (?).
Blue limestone, full of crevices. Red sandstone.
Shales ———. Depth, 90 feet. Several veins of Oil.
Sandstone and Conglomerate. Depth 120 feet. An excellent show of Oil.
Soapstone (?)
Limestone and Conglomerate, very hard, and with many crevices.
Red Sandstone.
Grey Shales. Depth 207 feet. Evidence of Copper, the tools coming up coated with that metal.
Conglomerates, with Iron and Manganese.
Very hard rock. Depth 300 feet. Struck a vein of salt water. Gas strong and burning on the Sand Pump.
60 feet of Black compact Shale. Small vein of Oil below.
Conglomerates.
Hard rock, } 400 feet. Gas very strong. Struck a vein of salt water
Shales and Sandstone, } and Oil.
Sandstone. 430 feet.

The general character of the rocks enumerated, would seem to imply that the strata passed through belong near the base of the Lower Carboniferous Series, and are similar to what may be observed at the Manganese Mine, on Shepody Mountain. The so-called *Soapstone* is probably a *fire-clay*, such as occurs at the last named locality; while the indications of copper and manganese may be due to secondary ores derived from subjacent metamorphic beds. I have not however seen any specimens of the rocks removed, and am therefore unable to pronounce positively on their character.

At the time of my visit, operations had been temporarily suspended, during the putting down of copper pipes for pumping. I observed, however, the strong escape of gas from the well, bubbling through a mixture of water and oil, and also observed the latter substance floating on the surfaces of springs in the vicinity. I have since been informed, that after the sinking of the pipes, several gallons of oil were removed in a single day's pumping.

Besides the locality above referred to, petroleum has been observed at several other points in this district, sometimes in a liquid form, escaping with the water of springs, at others in an oxydized condition, forming a thick tarry substance, termed *maltha*.

On the western side of the Petitcodiac River, an American Company have undertaken to bore for oil, on Stevens' Brook, near Hillsborough. At the time of the examination of the locality by Mr. Hartt, operations had but just commenced, and pending the arrival of a steam engine, the boring was carried on by hand. The depth then reached was only twenty five feet, the excavation being made in a friable red sandstone. A few feet from the latter, an adit had been driven into the foot of the hill, and had become partially filled with water, on the surface of which a thick mineral oil was floating by bucketsfull.

With the Sandstones of this locality are beds of blueish shale, and compact impure concretionary limestone, with numerous irregular masses of jaspery agate.

The last point at which I have had an opportunity of observing the presence of mineral oil, is the neighbourhood of Elgin Corner in Albert County, where several of the springs were found to be thoroughly impregnated with this substance, so as to be rendered unfit for ordinary use. The most marked of these springs is on the land of David Steves, and but a short distance from where we had already recognized the existence of Albert shales. A gas bubbles constantly from the water, and the latter tastes and smells strongly of petroleum. I did not, however, observe any distinct oily films, though the iridescence due to the latter was sometimes present.

In attempting to arrive at positive conclusions as to the probable quantity and value of Petroleum in Southern New Brunswick, we are immediately met by the uncertainty which still prevails in other portions of America, with regard to the origin and mode of action of oil-wells. In the absence of certain data from which to judge, we may briefly allude to the principal facts which favour a belief in the existence of the latter in the districts above enumerated.

In the first place, the geological age of the formations where these springs occur (already shown to be near the base of the Lower Carboniferous Series), is the same as that of the great oil-regions of Pennsylvania and Ohio.

Secondly, the large quantity of Albertite, if the latter be properly regarded as an altered oil, shows the former existence of this substance in a fluid condition, filling cavities in the disturbed strata. If we suppose the greater part of the oil to have become converted into the so-called *coal*, it is not reasonable to suppose that only a single deposit of the latter exists, and if not, other large beds of Albertite are to be expected, a result as important economically as would be the discovery of oil-wells.

Thirdly, the wide area over which actual indications of petroleum have been observed, goes far to indicate the general presence of the latter. It is no objection to such a belief that but trifling quantities of oil have as yet been obtained at the several localities, for such is often the case, where continued search leads to profitable yields. Indeed, so great is the uncertainty attending the discovery of actual wells, that in the Pennsylvania oil-district, according to Professor Evans,* "it is one chance out of many to strike oil at all, even in neighbourhoods where it exists in abundance." The same author observes that the presence of oil on the surface of water in springs is not a reliable indication of the original well, as currents of the latter may have carried the oil to considerable distances; gas springs on the contrary, and especially the finding of large quantities of imprisoned gas, are regarded as good indications that oil is near.

We leave this interesting subject, with the hope that operations of a sufficiently extended character will be persevered in, until the question shall have been definitely settled, whether or not this valuable substance is to be

* See an Article on the action of Oil Wells in September No. (1864) of Silliman's Journal.

sought for in this portion of America. We may add, that the district about Elgin would seem to be a favourable one for the prosecution of such undertakings.

Freestones, &c.—Among the useful minerals of the Lower Carboniferous Series, the gray sandstones of Albert and Westmorland Counties, so extensively used for building purposes, occupy a prominent place. The principal quarries are the following:—

Albert County.—Mary's Point and Grindstone Island—Albert Stone Quarries.
Cape Demoiselle—M'Kay's and Stuart's Quarries.
Westmorland.—Dorchester Freestone Quarries.
Sackville Parish, Joggins—Westmorland Olive Freestone Quarries.

At all of the above localities, operations of a more or less extended character are carried on, and large quantities of stone are annually exported or employed for local use.

Grindstones, also highly prized, are obtained at most of the above named quarries.

Iron.—This metal, though occasionally found in connection with other ores as a part of the series under consideration, does not occur in sufficient quantity to be of economical value.

Lead.—The principal locality at which this metal occurs in Lower Carboniferous rocks, is the foot of Dickie Mountain, near the Fingerboard, Norton, where limestone of this age holds both lead and copper. As the ores have probably come from the underlying metamorphic beds, they have already been described in connection with the latter. (*See useful Minerals of Kingston Group.*)

Manganese.—This is by far the most abundant ore present in this series, and has been observed at a number of points.

a. In the neighbourhood of Quaco, between the latter and Rogers' Head, the occurrence of manganese has already been pointed out, both as present in Carboniferous rocks and the overlying New Red Sandstone. The metal seems to occupy the line of a fault in the former, and irregular beds and pockets, in a breccia referred to the latter. The largest bed observed was from one to two feet in thickness. The same metal occurs as pebbles in the associated limestone, and with the latter in a coarse conglomerate.

b. On the western slope of Shepody Mountain, in a situation geologically similar to that at Quaco, manganese has been extensively mined, as described in my Report of 1864. Since the date of my first visit, operations have continued with increased vigor, and a new steam engine has been erected for pumping and for removing the ore. The manganese at this locality occurs at the base of the Carboniferous conglomerate, separated from the older metamorphic series (Cordaite Shales) only by a bed of *fire-clay*. The metal occurs in irregular beds near the surface, but farther under the mountain is more evenly distributed. Native copper has been reported as occurring in quartz veins, associated with the conglomerate.

c. The manganese mine of Mr. Davidson, situated at the source of the Hammond River, and upon the Parish line between Hammond and Sussex, was also alluded to in my Report of last year. The locality has since been visited by our party, and the ore has been found, as then described, to occur in semi-metamorphic Carboniferous limestone, containing *Terebratulae*, and also in "Drift." In the former the metal, of variable thickness, is included between distorted beds of the limestone, and is associated with *Barytes*, *Calc Spar* and *Limonite*, (*hydrous Peroxide of Iron*). The deposit from the drift gravel has been worked out, and operations have been abandoned at both points. Further exploration, however, would be very desirable.

It will be observed that at all the three localities above mentioned, viz., Quaco, Shepody, and Sussex, this ore would seem to occur in the same geological position, near the base of the Lower Carboniferous Series, as will be more apparent from the following comparison :—

Quaco.—First Carboniferous Conglomerate, (with pebbles of the two following) :—
Manganese.
Limestone.

Sussex.—Second* Carboniferous Conglomerate.
Manganese and Limestone.

Shepody Mountain.—First (?) Carboniferous Conglomerate.
Manganese.
Limestone and Fire clay.

It may be added that the lead of Norton occupies a similar position, in limestone at the base of the Carboniferous System.

CARBONIFEROUS SERIES.

Distribution.—The rocks of the Carboniferous System, irrespective of the great and important Gypsiferous Series last described, occupy, in the more central portions of the Province, a district not exceeded in extent by that of any other formation in New Brunswick. Bounded on every side, except that which faces the Gulf of Saint Lawrence, by the red rocks of the Subcarboniferous Series, the position and outline of the latter, already described, is a general indication of the extent and distribution of the Coal Measures. As but a very small portion of this large area has been included within the field of our labours, it will be sufficient to refer very briefly to its outline and general characters.

Occupying a triangular basin, of which the two principal sides are from one hundred to one hundred and sixty miles in length, the Coal Measures of New Brunswick have their western limit near the Oromocto Lake. From this point as the apex of the triangle, they widen gradually to the eastward, and occupy, on the line of the Saint John River, the entire district between

* The first conglomerate of Hammond River is a thin deposit.

Spring Hill, above Fredericton, and the lower side of Otnabog Lake, in Queen's County. On the eastern side of the river, their outlines are less accurately known, but they have been found to include most of the country near the head-waters of the Miramichi and its tributaries, as well as to the southward along the Washademoak, spreading on the Gulf of Saint Lawrence from New Bandon, Gloucester County, to Shediac, and possibly beyond. The outline of that portion of the series represented in the Map, has been laid down somewhat arbitrarily, except along the Saint John River, where it has been directly observed.

In addition to the region above described, a few detached areas belonging to this series are represented among the Carboniferous districts along the north shore of the Bay of Fundy.

CHARACTERS.—The rocks of the great central coal basin are entirely of sedimentary origin, and graduate from coarse silicious conglomerates and grits, through several varieties of sandstone, to sandy shales. The latter are comparatively rare, and true shales still more so, although the latter constitute beds of some thickness in the more central portions of the district. The most common rocks, especially on the western side of the Saint John, are sandstones, generally silicious, which pass insensibly into grits and very coarse conglomerates, the latter increasing in number towards the border of the basin.

In *colour*, the rocks referred to differ remarkably from those of the series last described. While the latter are almost universally of bright red or reddish brown colours, the rocks of the Coal Measures are almost as universally grey. Reddish beds, however, are not entirely wanting, (as at Grand Lake, and elsewhere,) and at times greenish, yellow, and even pure white sandstones occur. These varieties of colour may in part be due to the presence or absence of plant remains, such as *Calamites*, *&c.*, which are very abundant throughout these rocks.

The materials out of which the conglomerates and sandstones of the Coal Measures have been formed, have not been clearly recognized. In the western part of York County, where only I have had an opportunity of studying them, the pebbles are very generally of pure quartz, jasper, or quartzite, enclosed in a sandy matrix. Boulders of altered slate and diorite are also sometimes seen, and the matrix becomes more felspathic, as if derived from granite. Unlike the Lower Carboniferous rocks, they are seldom calcareous.

AGE.—The precise equivalency of the different members of the great New Brunswick coal-field with those of Nova Scotia, where the succession has been most carefully worked out, is still a matter of some uncertainty. The study of the fossils, collected from various portions of the basin, has led Principal Dawson to observe, that there is a mixture of the Floras of several different horizons, possibly due to the comparatively small thickness of the Carboniferous beds. The plant-remains (*ferns*, *&c.*), from the region of Grand

Lake, are believed by that author to be on the horizon of the middle coal formation, though tending to the upper, while those collected by Mr. Matthew, from Gardner's Creek, more nearly belong to the Millstone Grit. Descriptions of many of these plants, including the names of all those yet collected in New Brunswick, by Messrs. Hartt, Matthew, and others, may be found in a paper by Dr. Dawson, entitled a "Synopsis of the Flora of the Carboniferous Period."

Topographical Features.—In the term *basin*, already frequently applied to the district occupied by the rocks of the Coal Measures, we have the general character of that district sufficiently indicated. Lying in a trough or shallow depression, left by the folding of the older metamorphic series, and nowhere themselves much disturbed from their original horizontal position, the Carboniferous strata occupy a broad expanse of comparatively low and level land, much depressed in some portions of the basin, where lakes of considerable size are found, and rising gently towards the borders. The Saint John River, entering the district a few miles above Fredericton, drains with its tributaries the western and central portions, while the Miramichi, and other streams which flow into the Gulf of Saint Lawrence, perform a similar office for the more eastern parts.

Agricultural Capabilities.—Compared with the soils of the Lower Carboniferous districts, those of the Counties underlaid by the Coal Measures are generally poor and unproductive. Derived from rocks composed largely of grey sandstone and shale, they are usually themselves grey in colour and light in texture. Where the former prevails, the soil is usually sandy, where the latter, it is as commonly a stiff clay. From the level character of the country, drainage is frequently imperfect, and sphagnous swamps, bogs, or low sandy barrens, are abundant, frequently extending over large areas. Intersected however by several of the principal rivers, which in the spring freshets annually submerge large districts, the amount and quality of the intervale lands is nowhere exceeded in the Province. Excepting where the latter occur, settlements are almost entirely wanting.

For very excellent remarks on the soils of the Coal Measures, as well as upon those of other geological formations in New Brunswick, we may refer the reader to the Agricultural Report of Prof. Johnston.

Useful Minerals.—*Coal.*—The only locality where mining operations have yet been carried on for this mineral, is the region about the Grand Lake, where, however, the beds do not exceed a thickness of twenty inches. Coal has also been reported from a great number of other localities embraced within the district under consideration, but has nowhere been found to exist in profitable quantities.

The absence of this mineral over so wide an extent of country where the rocks are clearly those of the Carboniferous Period, has always excited surprise, and hopes are still entertained that some portions of the district, much

of which is still covered with forest, will yet be found to be productive. If, however, the suspicion of Dr. Dawson should prove to be correct, that only those beds of the Cumberland coal-field are here represented, which under and overlie the workable coals, there is little to be expected.

During the past year, several attempts have been made to obtain this mineral in the settlement of Harvey, near the western limits of the coal-field. A visit to the locality by the writer, has convinced him that the operations begun in this quarter cannot result otherwise than in failure. With a very moderate easterly dip, and at a very short distance from the Subcarboniferous Series, the Coal Measures can here have but little thickness, while their coarse character, and the abundance of conglomerates, are very unfavourable to the existence of coal. The inducements which have led to the search for the latter, are the presence of numerous pieces of this substance contained in the sandstone, but these are only the altered remains of plants, common everywhere in rocks of this age. The few seams which exist never exceed a few inches in thickness.

If any portion of the central basin should prove to be productive, it is most likely to be along its eastern border, in the Counties which front the Gulf of Saint Lawrence. It is, moreover, to be remembered, that the coal occurring in this series is a true caking coal, and bears no relation to the so-called coal of the Albert Mines.

GENERAL REMARKS UPON THE CARBONIFEROUS.

A. Origin of the Beds.—By examining the materials out of which rock-formations have been built, and regarding the greater or less degree of wear undergone by the former before consolidation, we have the key to their whole history. A mass of stone, no matter what its character, broken off by waves or currents from some larger mass, ground and polished by constant attrition, and subsequently heaped up with hundreds of others, which may or may not be like itself, to be with the latter firmly cemented together, and raised far above the ocean in which it was originally formed, is still an unmistakeable evidence of the beds from which it came, and tells us at once of the physical changes which the latter have undergone.

In the rocks of the Carboniferous Age, as developed in New Brunswick, the tracing of such evidences is a very easy and a very interesting study. In the Lower Carboniferous Series, more particularly, the conclusions to be drawn from the examination of its various formations, are remarkably striking and instructive.

It will be remembered that in the description of the coarse conglomerates occurring at the base of the series, in the Valley of the Kennebeckasis, along the Hammond River, and among the promontories of the coast, it was stated that the rocks were in each case composed of materials derived from the

older metamorphic hills upon which they rest. That such is in reality the case is plain, for the different pebbles out of which the conglomerate is built, still retain all their original characters, and may be directly compared with the beds from which they came. Many illustrations of this fact have been already given, especially among the formations of Albert County, and along the Bay of Fundy, which have been made principally from the wear of the Upper Devonian Series; but nowhere are they more striking than in the valley of the Kennebeckasis, both for the readiness with which the rocks may be recognized, and the conclusions to which their comparison has led. The conglomerates in the valley referred to, hold numerous pebbles, sometimes as much as a foot in diameter, of syenite, granite, or metamorphic limestone, in every way identical with the same rocks in the Portland Series below them, and evidently derived therefrom. It will, however, be apparent, that as the latter is the oldest group of rocks represented in the Province, and on either side of the principal fold is covered with the later deposits of the Huronian (?), Silurian, and Devonian beds, these must all have been removed before the former could have been exposed, or fragmentary materials be derived therefrom. Hence we are obliged to adopt the conclusion already pointed out by Mr. Matthew, and unmistakeably indicated in the character of the beds, that "currents or other agencies of vast force or long continuance, (perhaps both,) held sway over that region at the opening of the Carboniferous age," and that by the eroding power of these currents the superincumbent beds were worn away. Moreover, from the very general occurrence of these conglomerates among the Subcarboniferous rocks of the Lower Counties, we infer that the areas traversed by these currents must have been numerous and wide-spread.

In the rocks of the same series surrounding the great central coal basin, the absence of such coarse conglomerates is very remarkable, and shows that in physical and geographical conditions this portion of the Province differed somewhat from that above described. Here, too, we have a new feature introduced in the presence of volcanic products. That the curiously altered sandstones, claystones, &c. of Hampstead and Harvey, were formed through the influence of igneous action, is evident from their constant association with beds of trap and amygdaloid, having been, with the latter, probably formed beneath the pressure of the sea. Their connection, moreover, with unaltered shales, and limestones abounding with marine animals, prove that they were not all directly affected by these eruptions, but were merely formed of the products to which the latter gave rise.

The abundance of limestones, associated with thick beds of gypsum, throughout the Lower Carboniferous Series, and their intimate relations with the coarse conglomerates of the lower Counties, would seem to indicate, as pointed out among the similar beds of Nova Scotia by Principal Dawson, that deposits of several different kinds may have been in process of formation within comparatively small districts. It is probable that while the waves and powerful currents were building up the coarse conglomerates

along the margins of the older metamorphic ranges, animal life, giving rise to the accumulation of calcareous beds, was abundant in the deeper waters and layers of fine mud, now hardened into shale, were forming. There were oscillations of level also, and beds of fine or coarse-grained sandstone were made where shales or conglomerates were produced before, each alternation in the character of the rocks being an evidence of some change in the conditions under which they were deposited.

Principal Dawson, in his Acadian Geology, has explained the formation of the great gypsum beds of Nova Scotia, on the theory of volcanic action near or in seas tenanted by lime-secreting animals; the former giving rise to streams of sulphuric acid, which, flowing beneath the ordinary sea-water by their greater density, have come in contact with beds of calcareous matter, converting the latter into gypsum. The similar relation of this substance to the beds of marl and limestone with which it occurs, renders it probable that the same explanation may be extended to New Brunswick, where the evidence of intense volcanic activity among the later formations of the Devonian Age, constitutes the most marked feature in that era. It is, however, not a little remarkable in this connection, that though limestones are abundant among the Subcarboniferous rocks of the central basin, where the associated beds have largely been formed from volcanic materials, gypsum is quite absent, no deposits of the latter having been yet observed.

The origin of the calcareo-bituminous shales of Albert County, and their associated beds of liquid and solidified oils, is even more puzzling than that of the gypsum which accompanies them. Their identity in geological age and general character with the shales of Horton Bluff and Gaspereau River in Nova Scotia, would seem to imply a correspondence in their mode of formation, the latter, as shown by Dawson, having been produced by the gradual accumulation of fine mud in waters abundantly tenanted by fish, while upon the neighbouring shores, Lepidodendra and other carboniferous trees were growing. Between the two localities,* however, there is one prominent difference, in the absence among the Horton beds of the great deposits of bituminous matter which are so remarkable in the region about Hillsborough, in New Brunswick. If, as we have supposed, the latter are due to the oxydation and hardening of oily matter derived from the decomposition of fish-remains, the deposit may have accumulated in open fissures in a period subsequent to the formation of the shales, producing extensive oil-wells, to be compared with those opened within the last few years in Pennsylvania and Ohio, and indications of which are also abundant in many parts of the district now under consideration. The subject is, however, still wrapped in great obscurity, much of which may be removed when the origin of *liquid* oil-wells shall have been more completely understood.

In all the deposits above referred to, with the possible exception of the Albert Shales, the character and alternation of the different rocks indicate

* The bands of limestone, referred to by Dawson, as distinguishing the beds of Horton Bluff, have been observed by Mr. Hartt and myself among the fish-bearing shales of Elgin.

an origin at or beneath the level of the sea, and also that there was a gradual subsidence of the land when the earlier beds were formed. How great must have been this subsidence is evident, when we consider how elevated were the folds left at the close of the Devonian Age, from which, however, all the upper portions were removed, exposing, as in the Kennebeckasis valley, even the original Azoic rocks, at the very base of the geological series. This subsidence, moreover, was slow and not continuous, for the alternations of coarser with finer beds, and the occasional formation of thin seams of coal, show repeated oscillations near the sea-level.

In passing from the Lower Carboniferous Series to the consideration of the Coal Measures which succeed, the evidence of the rocks still proves the general prevalence of aqueous conditions, and the formation of deposits under the influence of powerful currents. The seas of the epoch, however, were much less deep than in the earlier period, and limestones and gypsum were no longer formed. Conglomerates and coarse sandstones, filled with drift-plants, are the most abundant rocks, and tell us only of gradually emerging sand-reefs, or beds of gravel, subject to constant alteration, and occasionally giving birth to a few straggling plants, or detaining and burying those floating by in the changing currents. Some portions of the basin were indeed above the water, and swamps, in which grew luxuriant forests, prevailed in the more central regions, as at Grand Lake and elsewhere; but those prolonged conditions, so remarkable in the Coal Measures of Nova Scotia, of estuaries and lagoons, extensive forests, and low peaty swamps, giving rise to the accumulations of enormous masses of vegetable matter, now represented by the coal-beds, do not seem to have been present in New Brunswick, where such deposits never exceed a few inches in thickness. It is, however, to be remembered, that even for the formation of a single foot of coal, there must have been, as shown by Bischoff, Dana, and others, an accumulation of vegetable matter at least eight feet in depth, the remaining seven having been subsequently lost by chemical alteration and compression. Future observations may show that these swamp-conditions were more common and abundant than is now thought to have been the case, but a wide distinction will still remain in this respect between the Carboniferous rocks of New Brunswick and those of Nova Scotia.

B. Disturbances and Foldings.—Like the Azoic, Silurian, and Devonian formations which have preceded them, the rocks of the Carboniferous Age no longer hold their original horizontal position. An examination of the Sections at the close of the Report, already explained as regards the older metamorphic series, will show that while these latter are covered unconformably by the conglomerates, shales and sandstones of the Carboniferous Period, these in turn have themselves been tilted, and pressed into a series of greater and smaller folds. They now stand in positions variously inclined to the horizon, and at times, as already shown in the case of the formations of this age at Gardner's Creek, have been completely overturned. Faults

and fissures abound along the lines of these disturbances, and downthrows have also been observed.

That these upheavals and dislocations were produced in the interval between the close of the Devonian, and the opening of the New Red Sandstone Era, which is to follow, is evident, from the fact that the Carboniferous beds are unconformable to the older metamorphic series, and are composed of materials derived from them, while they in turn have their tilted and denuded edges covered by the deposits of the Triassic seas. There is, however, a general correspondence between the older and the later groups in the direction of the folds, showing that the force, whatever its nature, which produced the disturbances in the earlier periods, was still in action at the close of the Carboniferous.

Besides the *general* flexion and dislocation of the beds above referred to, there were also some local disturbances during the period we are now considering, most evident in the upheaval of the beds by intrusive igneous action. The most remarkable example of such uplifting is furnished in the cliffs of Quaco, where also many other successive events are finely portrayed. A description of this remarkable locality has already been given. (*See Section west of Quaco.*)

Between the Subcarboniferous Series and the rocks of the Coal Measures, there would appear to be much discordance in the amount of their upheaval, and I should not be surprised if decided unconformability should yet be established, the latter, in the central basin, never having so far as I am aware, the high dip found among the Lower Carboniferous beds which underlie them.

METAMORPHISM.—In the remarks upon this subject, at the close of the Devonian Age, it has been stated that three separate and successive stages may be distinguished in this process, viz:—Consolidation, or the mere cementing of loose materials, Partial Alteration, and Complete Metamorphism or Crystallization.

In the Carboniferous formations of New Brunswick, these changes are mostly confined to the first named stage, and more rarely to the second; re-crystallized rocks are almost entirely wanting.

Among the most firmly consolidated beds of this age are the coarse fragmentary deposits near the base of the series, as seen in the valley of Hammond River, and among the headlands of the coast, many of the latter equalling in hardness the older metamorphic groups, from whose wreck they have been built. From these to the soft beds of shale, penetrated by and filled with the remains of plants, there is every variety of gradation.

Of the second stage in the metamorphic process, the beds of this series also afford numerous examples, most prominent, however, in regions characterized by igneous activity. It was probably from partial alteration, produced by eruptive outflows, that the limestones in the cliffs of Quaco lost their colour and their fossils, while similar influences have wrought the

remarkable changes, already noticed, in the sandstones and shales of Hampstead, Harvey, and other localities along the margin of the coal-field. In the latter, the change has at times almost resulted in a re-crystallization of the minerals, the altered beds referred to being with difficulty distinguished from true porphyries.

In this connection, reference may be made to a very curious rock, apparently an altered sandstone, occurring in beds on the Kouchibouguac River, in Kent County, and known among the French as "*Gres a reflets.*" As implied by the latter name, its broken sides, no matter what may be the plane of fracture, exhibit brilliant reflecting surfaces when held at definite angles, although in other positions as rough and destitute of lustre as are ordinary sandstones. The mineral would seem to be the result of partial metamorphism, but I am ignorant as to the precise mode of its occurrence.

Condition of this portion of the Continent during and at the close of the Carboniferous Age.

In looking back to the general physical and geographical conditions which prevailed in this portion of America, during the progress and at the termination of the Upper Devonian Era, it will be remembered that through the lengthened periods when the different formations of the latter were in progress, the more southern portions of the Province (and probably the northern also,) were still, for the most part, below the level of the sea. They do not, however, appear to have been depressed to any considerable depth, and there were some districts sufficiently elevated to produce plant-sustaining marshes, and others even dry land, covered with a forest vegetation and tenanted by animal life. These, however, were not the prevailing conditions of the period, which was rather one of slow oscillations below the sea-level, accompanied by numerous volcanic outbursts, and a gradual sinking of the land, sufficient to build up by the agency of the waves, strata several thousands of feet in thickness. Towards its close these minor oscillations culminated in grander movements, and an epoch of revolution ensued, during which the beds, previously horizontal, were thrown into gigantic folds, and metamorphism and mountain-making followed the periods of comparative repose.

The ridges formed during this epoch of disturbance, and now represented by the various elevated lines of hills in the lower Counties, constituted at the opening of the Carboniferous Era, the dry land of the period, and against their flanks washed the waves, by whose eroding action the various deposits of the latter group were formed. There were still oscillations, and probably in the earlier portion of the age a somewhat rapid depression of the land, especially near the mouth of the Saint John River, and in the more easterly portions of the Province. The greater part of Saint John and Albert Counties were probably islands, surrounded by coral-building seas, while the Bay of Fundy, already outlined, was bounded on the south by the

Cobequid Hills of Nova Scotia, and was then a wide channel opening freely at both ends to the sea. Over the more central portions of the Province, also, the ocean still prevailed, for we there find limestones, filled with relics of marine life, and this vast bay, a western prolongation of the Gulf of Saint Lawrence, may have been connected with the waters of the Kennebeckasis valley by the great fault at the head of the Long Reach, through which the Saint John River now flows. Around the margin of this bay, and possibly over its entire extent, volcanic outbursts were frequent, and some of the conditions of the earlier Devonian Periods were again witnessed.

In passing from the Lower to the Middle and Upper Carboniferous formations, we find that the same series of minor oscillations were still in progress, but now no longer upon the margins of deep seas, while the general movement was one of elevation rather than depression. The extent of the great basin above alluded to became narrowed by the gradual filling up and raising of its bed, and in place of waters tenanted by marine animals, we have to contemplate the existence of wide-spread inland seas, or shallow fresh water lakes, with extensive marshes, covered with luxuriant vegetation. These swamp-conditions, however, as previously remarked, were of much shorter duration here than in the other great coal-fields of America, and, while the immense accumulations of vegetable matter, now stored in the form of *coal*, were being deposited in the neighbouring Province, New Brunswick passed with comparative rapidity through these elevatory movements, and was added to the permanently dry land of the Continent.

GENERAL REMARKS UPON PALAEOZOIC TIME.

We have now attempted to trace, from the evidence of its rocks and fossils, the gradual formation and growth of this portion of America, and to present a general view of its physical and geographical conditions during the different geological ages, constituting what is known as Palaeozoic Time. Before passing to the consideration of subsequent epochs of growth or alteration, it is interesting to compare the succession of events so far described, with those which characterized other portions of the Continent during the same eras.

The *Silurian Age*, the first of the Palaeozoic Series, does not, so far as known in New Brunswick, seem to have differed very greatly in its characteristics from what has been observed over the greater part of North America. It was an age of almost universal submergence, though to but shallow depths, and in the seas were to be found only the lower forms of animal and vegetable life; Trilobites and Brachiopods characteristic of the former, sea-weeds or marine Algae of the latter. Limestones, however, so abundant among the Lower as well as the Upper Silurian strata over the more central portions

of the Continent, do not seem to have been here represented among the former, although it is not unlikely that such may yet be found among the calcareous and fossiliferous formations in the north of the Province.

Of the *Devonian Age*, which succeeds to that above described, we know in New Brunswick only the later portion. No deposits, unless some part of the Kingston Series, have yet been found to represent the earlier and middle epochs of the era, and we are therefore without data from which to form comparisons with other regions of the continent. The want of these deposits, as stated in an earlier portion of the Report, may be due to the elevation of the land at this time above the level of the sea. In contrasting the formations of *Upper* Devonian age, as found in the Province and elsewhere in America, the most marked point of difference is the very general prevalence of igneous activity in the former, both as evinced in the thick volcanic accumulations of the Bloomsbury epoch, and also later, in those of Little River and Mispeck. As in other portions of the continent, however, dry land of greater or less extent had now succeeded to shallow seas, and there is evidence of a terrestrial vegetation, and of insect life.

In the period of upheaval, folding, and metamorphism, which separated the Devonian from the Carboniferous Age, we see the grandest and most striking of the physical events which mark the geological history of New Brunswick, as well as the feature in which that history is most strongly contrasted with what took place elsewhere on the continent. Throughout the Atlantic coast of America, including the great Appalachian region, where oscillations of level were most frequent during the Palaeozoic ages, this period of revolution did not take place until the close of the Carboniferous. Some slight elevations, accompanied by metamorphic changes, did indeed occur at the close of the Lower Silurian, and the slight unconformability between the rocks of the Saint John and Bloomsbury Groups, may indicate a corresponding oscillation here, but no great period of disturbance and mountain-making prevailed, until after the deposition of the coal beds. The events as observed in New Brunswick more nearly correspond with those of Canada, Maine, and Nova Scotia,* where, as in this Province, the Subcarboniferous rocks cover the upturned edges of Silurian and Devonian strata unconformably.

In the *Carboniferous*, or last of the Palaeozoic Ages, while there were some general points of resemblance between this and other regions of the Continent, there were also some marked differences. From the folding and metamorphism which brought the Devonian Era to a close, the conditions of general level which had hitherto prevailed, and which still continued to prevail, over a large part of North America, had here been succeeded by others of much greater diversity. There were numerous islands, peninsulas, and long narrow strips of land, possibly of considerable elevation, at some periods separated by deep oceanic waters or shallow straits, at others, sur-

*(Logan, C. Hitchcock, Dawson.)

rounded by extensive inland lakes. There were probably rivers of greater or less size, (for the inequalities of the land would naturally produce a flow of water from their sides), and marshes filled with a tropical vegetation. Volcanoes also seem still to have been in active operation, especially in the more central portions of the Province, and may, in part, have produced the oscillations indicated by the alternations of different stratified deposits.

As the Carboniferous Age was closing, and disturbances on a grand scale were affecting other portions of the Continent, similar changes, but in a much smaller degree, were again witnessed here. There were uplifts, foldings, and dislocations, accompanied by a breaking and hardening of the strata, but there was no metamorphism. The rocks are not *crystalline* rocks, and the coal deposits are those of the ordinary bituminous variety, which have not been changed by the action of heat. About the region of Albert County, these dislocations were especially numerous, but whether they were strictly cotemporaneous with the great period of Appalachian revolution or not, is still undetermined.

With the close of the Carboniferous Age, we reach also the termination of one great cycle in geological time. After repeated alternations of submergence and elevation, of wear and restoration, this portion of the continent had become comparatively stable. Oscillations of level did indeed take place at a later date, as they are undoubtedly taking place *now*, but, in general, they were sufficient to affect only the very border of the Province, and a long interval elapsed before the whole was again depressed beneath the sea. The organic world, also, hitherto of a character very unlike that of the present creation, was from this time of a more modern type, most of the ancient or Palaeozoic forms having disappeared.

MESOZOIC TIME.*

From the Palaeozoic rocks, to the description of which the preceding part of this Report has been mainly devoted, we pass to the consideration of another series, which marks the introduction of a new order of things in Geological History—the increase and prevalency of *Reptilian* forms of life, and the assimilation in the type of the vegetation to that which now exists.

These features characterize the great cycle of time, known as the Secondary or Mesozoic Age. Of the three periods into which this age is usually divided, the *Triassic*, *Jurassic*, and *Cretaceous*, the first, or period of the New Red Sandstone, is alone represented in New Brunswick.

NEW RED SANDSTONE OR TRIAS.

DISTRIBUTION.—The occurrence in this Province of deposits of later date than the Carboniferous Era, has long been a disputed question; for, while Dr. Gesner asserted in his Reports, that the sandstones of Saint Andrews—shown to be Devonian,—those of the Kennebeckasis and Petitcodiac Rivers, and certain deposits west of Gardner's Creek—which are Lower Carboniferous,—and the higher strata of Grand Lake, probably Carboniferous,—were all New Red Sandstones, Dr. Robb, on the contrary, was of opinion that no rocks of this age occur on the north side of the Bay of Fundy.

There are, however, three very limited areas on the Bay shore, where deposits of this period do exist. The first is between Gardner's and Ten Mile Creek, one and a half miles long and half a mile wide. The second is at Quaco, where they may be seen in the depressions, east, south and west of Quaco Head. They underlie the village, and probably extend along the shore to the eastern end of the settlement, where we observed them in contact with the older Devonian shales, which form the shore-line thence to Lower Salmon River. They also extend some distance beneath the waters of the Bay, and may thus connect with the first mentioned area. A third outcrop is on the low shore of Salisbury Cove, east of Owl's Head. Here the action of the sea, in removing a covering of sand and gravel, has exposed two patches of Red Sandstone.

CHARACTERS.—The bulk of the Secondary strata at the several localities above enumerated are red sandstones, but at Vaughan's Creek, (Quaco,)

* The remarks upon this division of the geological scale, as well as upon that of Cenozoic Time, which is to follow, are from the pen of Mr. Matthew, that gentleman having kindly undertaken the task of completing this portion of the Report, while I was myself engaged upon that which has preceded. The data upon which these remarks are based are, as far as regards the New Red Sandstone, chiefly from observations made by our party collectively; those upon the Post Tertiary Period are the results of Mr. Matthew's individual studies.

an upper member appears, having an entirely different aspect. It is a incoherent conglomerate, of a grey colour, consisting of sand and roun boulders of quartzite, altered slate, &c., derived from the hard sediments o the metamorphic hills northward, being, as Gesner remarks, "conformable to the red sandstones which constitute the lower member, and "perfectl stratified."

These latter consist chiefly of soft earthy sandstones of a bright red colour but layers of conglomerate, holding quartz pebbles mixed with fragments of grey and brown sandstone, are common in those at Gardner's Creek. From the coarser beds, and from detritus on the beach at the last named place, were gathered the only organic remains which we observed, viz., fragments of *coniferous wood.* As the majority of these were partly rounded and imbedded with pebbles, they were probably derived from the ruins of the Carboniferous strata, in which, at the distance of a few miles, such fossils may now be seen. One, however, bore no marks of transportation, and of it Dr. Dawson observes—"The fossil wood from the New Red Sandstone, though not well preserved, appears to be coniferous, and to have one row of discs on the cell-walls, in the manner of the mesozoic pines of the genus *Peuce* or *Pinites.*"

Many striking instances of oblique lamination were observed at the same locality, and, indeed, this irregular structure characterizes the formation. The influence of currents setting in three or four directions at consecutive periods, can be traced in the few layers represented in the wood-cut F, at the close of the Report.

At Quaco the lower beds are often concretionary or brecciated, while the more easterly deposit at Salisbury Cove, although agreeing in other respects, has but a slight dip (to the E. N. E. 10°,) and is of a pale colour. The rocks of the lower or red member can be readily distinguished from the Carboniferous and Lower Carboniferous formations which they accompany, (although frequently confounded with them by Dr. Gesner,) by the irregular thickness and truncation of the layers, by the absence of fine shales and hard massive conglomerates, and in general by their bright red colour.

The general course and inclination of the strata at Quaco and Gardner's Creek are remarkably constant, the dip being to the N. N. E. at angles varying from 25° to 45°, the highest beds at the latter place having the last named inclination. Here too, unless there are extensive downthrows on the south side of the numerous cleavage-planes by which the beds are intersected, the sandstones must attain a considerable thickness—probably 800 feet—seeing that they rise into cliffs 100 feet or more in height, and extend half a mile inland.

Age.—In an article entitled "Observations on the Geology of Saint John County, N. B.," published in the Canadian Naturalist, the Secondary age of the red sandstones east of Gardner's Creek was asserted. This will be evident on inspection of the Section D, where their western edge may be

seen to meet the highly disturbed Carboniferous strata, and also by the Sketch E, of their eastern termination, where the discordance is equally obvious.

These observations have been confirmed by an examination of the red sandstones of Quaco, which rest upon the limestone and conglomerate of the Lower Carboniferous formation unconformably, as may be seen on reference to the Section H, illustrative of this locality. These red sandstones, although intersected by numerous cleavage-planes, are not contorted or folded at any of the places where we have examined them.

From the features presented by the two series at Gardner's Creek and Quaco, we infer that a considerable period of time elapsed, during which the numerous thick beds of sand, gravel, clay, and calcareous mud, now forming the limestones, conglomerates, sandstones and shales of the Lower Carboniferous and Carboniferous formations on the coast, were hardened into stone, the imbedded trees which they contain silicified, and the whole series disturbed, pressed into sharp folds, injected with trap, and entirely removed in some places by denudation, before any sediments of the later or New Red Series were formed. The latter, therefore, can scarcely be older than the Trias. But in their main features, and in their relations to older formations, the red sandstones on the northwest side of the Bay of Fundy, agree with those which add so much to the fertility of Annapolis and Cornwallis Valleys in Nova Scotia, and no doubt mark in this direction the limit of that tidal bay, traversed by strong and variable currents, in which Dr. Dawson supposes the latter to have been deposited.

Loose beds of coarse shingle, which are found at the summit of the series, mark the influence of similar powerful currents and long continued wave-action on an exposed coast, at the *close* of this Period.

Topographical Features and Agricultural Capabilities.—The sediments of this series, situated as they are upon the southern margin of New Brunswick, and being of such limited extent, can have little influence on the agricultural capabilities of the districts in which they occur. They are soft and yield easily to the waves, whose destructive action rapidly undermines the cliffs, and enlarges fissures in the strata, thus forming "*drongs*" or perpendicular detached masses of rock, and giving rise to some of the most remarkable scenery on the coast.

Useful Minerals.—The only useful mineral known to exist in available quantity in these sandstones, is the oxide of manganese, found at Quaco. The character and mode of occurrence of the latter has already been noticed in another connection.

CENOZOIC TIME.*

Between the epoch of the New Red Sandstone, and the close of the Tertiary Age, a wide gap occurs in the geological record of this part of America. During this interval, extensive accumulations equivalent in age to the Oolite, Chalk, and Tertiary deposits of England, were spread over wide areas of this continent, embracing a large extent of country on both flanks of the Alleghanies, and the great western plains. The Islands of Martha's Vineyard and Nantucket, off the coast of Massachusetts, and certain *lignite* beds of Brandon, Vermont, indicate the eastern limit of these formations, which, if they ever existed here, were swept away by the extensive denudation marking the succeeding period of the "Drift or Newer Pliocene."

The phenomena which distinguish the latter epoch are noticeable in every part of the Province. For wherever the soil is removed, the rock beneath is found to be covered with numerous parallel furrows or grooves, having in general a north and south direction. These marks have been made by stones and fragments of rock, frozen to enormous masses of ice, which, impelled from the north over the surface of the country, have also given to the northern declivities of hills and rocky ledges, a rounded outline.

The accumulations of mingled mud, stones, and fragments of rock, resulting from the breaking down of prominent ledges, and the erosion of the softer beds by this agency, constitute the *boulder-clay*, and form the principal subsoil of the country. They are frequently well exposed by the wasting away of high banks along the sea shore, and occasionally in the river valleys.

At the close of the period last described, the whole Province, excepting perhaps the highest hills, was buried beneath the ocean; but during the next, which was an epoch of emergence, the superficial deposits of the preceding or "Drift Period," were exposed to the action of the waves, and while the coarser material was left on the hill sides and elevated plains, forming gravel flats and sandy terraces, the finer portion was washed away by the waters, and settling from them in depressions of the surface, formed the clay beds which fill valleys in various parts of the Province.

The continual rising of the land, and consequent retrocession of the ocean, would bring one area after another within the influence of the waves, and the sand-banks and flats formed at one period would be cut down and partially swept away in the succeeding; thus giving rise to the terraces met with on the coast and in the interior.

To this cause, viz., the gradual recession of the sea,—we may ascribe the terraces and *high* intervales of the Saint John River and its tributaries, below

* I may here repeat the statement, that the above remarks are the results of Mr. Matthew's individual observations, and are from his own pen. The views set forth are therefore to be considered as those of that writer only.—L. W. B.

the Grand Falls. For, the rising of the land being at times arrested, the sediment brought down by the river, would settle in the still water of the estuary which then existed at Woodstock and Fredericton, and by a further recession of the sea, a greater impetus being given to the current, the delta would be cut through by the river, and carried further down to form a new flat at a lower level, leaving a skirting of the older deposit rising in a terrace on both sides of the valley. This process, carried on for a lengthened period, would give rise to a series of river terraces, at different heights, in the valley of the Saint John, corresponding to those which border hill-sides along the coast.

The stratified clay and sand of this Epoch contain numerous organic remains of the creatures which inhabited the waters from which they were deposited. Those in the vicinity of Saint John have yielded about fifty species of Mollusca (*shell-fish*), ten Radiata, Bryozoa, and Articulata (*Star-fish, Corals, Barnacles, &c.*), and also three species of Algae (*sea-weeds*); while ten additional species are known to occur in other parts of the Province.

How long the elevation of the land above referred to continued, or to what limit the waters retired, we know not, but it is evident that it extended beyond the present shore of the continent, for, as may be gathered from the observations of Drs. Gesner and Dawson, former land-surfaces, indicated by the presence of stumps of trees, logs, and beds of peat, have been met with in shallow waters along the shore of the Bay of Fundy and Gulf of Saint Lawrence at various points, such as Grand Manan,* Cumberland Basin, and Miramichi; as has also been observed to greater depths on the coasts of Massachusetts, New York, and New Jersey.

At a subsequent period, the land thus elevated began to sink slowly beneath the ocean, and the vegetation which covered it was either swept away, or buried beneath deposits of sand and mud, such as the salt marshes of Albert and Westmorland Counties, and the marshes and *low* intervales of the lower courses of the Saint John.

This epoch of depression is that in which *we* live. On the coast of New England and the Middle States, the subsidence of the land goes on at the rate of about one foot in the century. Here the rate has not been ascertained, but the process is so slow that the marshes (where indications of the sinking of the land are most readily seen,) are built up by the addition of fine mud settling from the tidal waters of the Bay, so that no appreciable change appears.

There are certain fresh-water and terrestrial deposits, such as *river alluvia, calcareous marls, silicious earths*, and deposits of *peat*, belonging chronologically to both this and the preceding epoch, but which are more conveniently considered in connection with the later; for although they were no doubt in process of accumulation in the more elevated districts at the time that the low land was still submerged beneath the sea, and its surface-

* Also Frye's Island.—L. W. B.

deposits undergoing modifications attending the rising of the land, yet at every locality where fresh-water strata and peat accompany stratified clays and sands of marine origin, they are found to rest upon them, and therefore must have been formed at a later period.

The superficial deposits of the Province may thus be conveniently classified under three heads, indicating as many changes in the relative position of sea and land. These are*:—

The Glacial Period—In part at least an epoch of depression.
Champlain and Terrace Periods—A time of elevation.
Modern Period—A time of depression.

At a future time I hope to be able to give in greater detail an account of phenomena incident to these periods, more especially the *Life* of the second, as indicated by the organic remains in deposits along the southern shores of the Province, (and the application of the latter to Agriculture and the useful arts), to which account these remarks are introductory. Any information which will extend our knowledge of the subject, will be thankfully acknowledged by the writer.

GENERAL SUMMARY.†

In the preceding Report upon the Geology of Southern New Brunswick, the whole series of formations known to exist within that region has been described, and the age of each, so far as known, indicated. In conclusion, the following Table is given, to present in a synoptical form a history of the physical changes which these formations have undergone.

In the *first* column they are separated into three great divisions, based upon the state in which the remains of the vegetation are found. No carbonaceous matter has been observed in the New Red Sandstone, but it is presumed that it will resemble that of the Coal Measures.

The *second* column shows the great physical disturbances resulting from movements in the earth's crust, and furnishes a further means of separation into six or more minor divisions.

In a *third* column, the relative consolidation and alteration of the various formations is shown,—a change from loose layers of gravel, sand or mud, which depends not so much upon age as upon disturbance of the earth's crust, with intrusion of melted matter from beneath, dissemination of vol-

* The classification here given by Mr. Mathew, differs somewhat from that already used in the Tabular View, on Page 13. The latter, as before stated, has been adopted from the Manual of Professor Dana. For further remarks on the succession of the Post Tertiary Epochs, reference may be made to the last named work, also to an Address of Dr. J. W. Dawson, before the Natural History Society of Montreal, published in the Canadian Naturalist.—L. W. B.

† By Mr. Matthew.

ıshes in the strata, or the deep burial of sediments, where great accu-
ons are formed. Several stages of change are indicated, *coherence*
the particles in the beds become consolidated; *partial alteration* where
yers are hardened; *great metamorphism* where the rocks are frequently
lline, but the stratification is not obliterated; and *extreme alteration*,
› the evidences of original sedimentary deposition are almost or
ely lost.*

the *fourth* and *fifth* columns will be found respectively the local names
ı to the various groups of strata, and to the several formations with
h they are known or supposed to correspond.

SIFICATION OF THE SEDIMENTS OF SOUTHERN NEW BRUNSWICK ON PHYSICAL GROUNDS.

e of organic matter.	Disturbances.	Metamorphism.	Local Names.	General Divisions.
	Horizontality not at all, or but slightly disturbed	Incoherent.	Boulder clay, Stratified clay, Gravel, &c.	Newer Pliocene, and Post-Tertiary.
umen present. al of the ordi- ry character, it.)	Corrugations absent, not folded with Carboniferous.	Particles slightly or not at all coherent.	New Red Sandstone.	Trias.
	Corrugated, but not involved in the great folds of the older strata.	Slight or partial.	Coal Measures. Albert Shales and Sandstones. Kennebeckasis Conglomerates and Shales. Carboniferous Limestone.	Coal Measures, and Lower Carboniferous.
All involved in the great corrugations impressed at the close of the Devonian Age. Bitumen absent. Carbonaceous matter converted into anthracite & impure graphite.		Partial, often great, where volcanic sediments prevail.	Mispeck Group. Little River " Bloomsbury "	Upper Devonian.
		Great, not unfrequently extreme.	Rocks of Kingston, Nerepis, and Bellisle.	Middle and Lower — Devonian ? Upper and Middle — Silurian ?
			Not recognized.	Upper part of Lower Silurian.
	Undulations anterior to the great folds of the Devonian Period.	Great, but extreme only in volcanic sediments.	St. John Group. Coldbrook "	Primordial Period, (Dana.) Huronian.
	Line of contact with Coldbrook Group undulating.	Great, often extreme.	Portland Group.	Laurentian.

* For further explanation of the different stages of metamorphism as illustrated in New Brunswick, see the observations on this subject in the general remarks at the close of the Silurian and Devonian Ages.—L. W. B.

CONCLUDING REMARKS.

I cannot allow this Report to be concluded, without expressing to the various gentlemen who have aided in its preparation, my thanks for the services they have so kindly offered. My obligations are more especially due to my fellow-travellers, Messrs. Matthew and Hartt, both for their assistance in the field, and subsequently, in the study of the rocks and fossils collected; to Prof. Dawson, of Montreal, for a revision of some of the more important data, and an examination, in connection with Prof. Hunt, of selections of the metamorphic rocks; and to Prof. Verrill, of Yale College, and Mr. Scudder, of Boston, for valuable contributions. It had been hoped that the papers of the last two gentlemen, (that of the former on "The Mineral deposits of the western border of New Brunswick, and the Geology of Grand Manan," and that of the latter on the Insects of the Devonian Rocks near Saint John,) would have been completed in time for publication with the main body of the Report; but as this has been found impossible, it is intended that they shall appear in the form of Appendices.

In addition to the contributions last named, Mr. Matthew has kindly offered, from the reports of Dr. Gesner, the observations of Prof. Hitchcock in Maine, and data collected by ourselves during the past season, to add a short article on the Geology of Charlotte County; also one on the comparison of the Coast (Devonian) Series with the Metalliferous Rocks of the Eastern Townships of Eastern Canada.

Mr. Hartt will further contribute a Paper "On the Devonian Plant Locality of the Fern Ledges, Lancaster, N. B., with a detailed Section and Notes on the Fossils."

These, with a List of New Mineral Localities and of the Fossils of the Province, will appear as soon as they can be prepared.

APPENDIX A.

ON THE DEVONIAN PLANT LOCALITY OF THE "FERN LEDGES," LANCASTER, NEW BRUNSWICK,

WITH A DETAILED SECTION, AND NOTES ON THE FOSSILS.

BY C. FRED. HARTT, A.M.

The following description of the Devonian plant locality at Lancaster, in the vicinity of Saint John, and the section of the strata, are compiled from notes made during the summers of 1861, '62, and '63, during which I undertook to examine carefully every bed exposed at the locality, and to collect as complete sets as possible of the fossils occurring in each.

Of the several localities for fossil plants in the vicinity of Saint John, the richest and most interesting is that of the "Fern Ledges." These are a series of ledges exposed on the sea shore, between high and low-water mark, at the foot of the properties of Messrs. N. S. Demill and Zebedee Ring, Duck Cove, Lancaster, about a mile west of the town of Carleton. The ledges are formed by the outcropping edges of beds of sandstone and shale, belonging to the Little River Group of Mr. Matthew. These have a strike of about W. 10° N., and a southerly or seaward dip of about 45°. This strike corresponds very nearly to the trend of the shore, along which, rounded and much worn by wave action and buried in sea weed, their edges run like furrows. The shale beds, in which the plants occur, are, on account of their softness, everywhere so worn away by the waves from between the enclosing sandstones, as to be in only a few places accessible.

Only near high-water mark are the ledges of any height, and from these the plant-bearing shale beds are almost entirely removed. The ledges extend along the shore for some 825 paces, with a width of 300 feet, more or less, exposing a thickness of strata of about 150 feet. Numerous faults occur at the locality, the principal of which, on the easternmost side of the most prominent projecting ledge, and whose direction is S. 30° W., is a downthrow of about 50 feet.

Directly in front of the ledges, and about half a mile from the shore, is a series of skerries laid bare at low water, called the "Shag Rocks." I have never visited them, but the beds of which they are composed have an apparent east-westerly strike, and a high dip to the southward. They are probably the upper members of the Cordaite Shales.

Beds of sandstone and shale, similar to those at the Fern Ledges, show themselves on the shore about three quarters of a mile to the westward.

They contain the remains of a few species of plants, identical with those occurring at the "Ledges," but the beds are higher up in the series. This locality, called the "Calamite Ledges," has not been so carefully examined as that to the eastward. I have collected there the following species, nearly all of which are common to the two localities:—

Cordaites Robbii, DAWS.—Extremely abundant in certain layers of black shale, and very finely preserved.

Sphenopteris Hitchcockiana, DAWS.—Abundant in detached pinnules.

Pecopteris discrepans, DAWS.—Apparently rare. Have found but a single pinnule.

Cardiocarpum cornutum, DAWS.—Not infrequent, associated with cordaites, calamites, &c.

Calamites transitionis, GŒPPT.—Abundant.

C. cannæformis, BRONGNT. "

Annularia acuminata, DAWS.

Pinnularia dispalans, DAWS.—Common.

Psilophyton? glabrum, DAWS.

Stigmaria ficoides, (*var.*) BRONGNT.—A single specimen with rootlets attached was found by my father, J. W. Hartt, in a bed of sandstone, about half-way up in the section here exposed.

Lepidodendron Gaspianum? DAWS.—Two or three ill preserved specimens of a Lepidodendron, which Dawson has referred with doubt to this species, were collected at this locality by Mr. Matthew and myself.

The sandstone at the Fern Ledges is very compact and hard, and of a grey colour. It contains many plant remains, but usually in a badly preserved state. Thin beds of arenaceous shale, of a fine texture and dark grey colour, becoming black sometimes, or passing into light greenish-grey, are interstratified with the sandstones, and these beds are highly charged with plants, which occur preserved as graphite, every nerve and nervule of a fern leaf being as distinct as in a pencil drawing.

It had been ascertained several years ago, by Gesner, Robb, Dawson, and others, that the beds of the Little River Group were fossiliferous, and ill-preserved plant remains had been observed in the sandstones of the "Ledges." Mr. Matthew, who had previously discovered in the shales at the foot of the City of Saint John, near the Barracks, the plants which Dawson described in his paper on the "Flora of the Precarboniferous, &c.," collected in 1860, at the "Ledges," from one of the exposures of plant bed No. 1, of the following section, some obscure markings which were probably leaves of *Asterophyllites longifolia*, DAWS.; but it was not until May, 1861, that I found that these rocks were richly fossiliferous, and discovered in beds Nos. 1, 2, 3, and 8 (?), a large number of fossil plants, principally ferns, a remarkable Crustacean, *Amphipeltis paradoxus*, SALTER, and a *Spirorbis*. Messrs. Matthew, W. R. Payne, James Hegan, and Lunn, took part in the explorations which were carried on during the summer, Mr. Matthew discovering, among other things, a new species of *Eurypteris*, *E. pulicaris*, SALTER; while Mr. Payne secured a single specimen of a trilobite, still undetermined, the only one the locality has afforded.

These discoveries proved so interesting that Principal Dawson, to whom I communicated them, paid a visit to Saint John, and examined the locality in person. The collections made were put into his hands, and the plants were described in an interesting and valuable paper published in the Quarterly Journal of the Geological Society, entitled, "*On the Flora of the Devonian Period in Northeastern America.*" The number of plants obtained thus far from the Lancaster localities was 36, which, with the three species of Crustacea, the Spirorbis, and the three species of plants previously collected in Saint John by Mr. Matthew, made the number of species of animals and plants ascertained to occur in the Little River Group, 43.

The following summer I spent thirty days at this locality, being rewarded by the discovery of some ten or more new species of plants, principally ferns, and by securing larger and more perfect specimens of many of the species described by Dawson from mere fragments. But the most valuable and entirely unexpected discovery, was that of *remains of insects*, of which five species have been obtained. These specimens are in the hands of my friend, Mr. Scudder of Boston, the well known Entomologist, for description. During the summer, I began the task of examining every bed in the section at this locality, a task not easy to perform, where the tough rocks lying below high water mark and buried in a luxuriant growth of sea weed, are worn away in such a manner as to make it difficult to work them.

In the summer of 1863, I spent eight days at the locality, during which time I finished my section. Several new plants were discovered, together with many quite perfect specimens of several hitherto known only as fragments. Of the latter was a large frond of *Neuropteris polymorpha*, DAWSON.

The Crustaceans *Amphipeltis paradoxus*, SALT., and *Eurypteris pulicaris*, SALT., were described and figured by Salter in the Journal of the Geological Society for February, 1863.

A paper by Mr. Geo. Matthew, entitled "Observations on the Geology of Saint John County, New Brunswick," in which the relations of the Little River Group to the other rocks of the vicinity of Saint John were considered, appeared in the Canadian Naturalist in the preceding year.

The number of species of plants now in my hands for determination, is not far from twenty-five. It is my intention, after having made yet more careful examinations of the rocks of the Little River Group, to describe and figure them in a *Monograph of the Flora and Fauna of the Devonian Period in the vicinity of Saint John*, which paper I hope ere long to have ready for publication.

In the following Section, the measurements were taken along a line crossing the beds at right angles to their strike, from high-water mark near the bathing house stairs, to low-water mark. The rich fossiliferous shale beds, or *plant-beds*, as I shall term them, are numbered from below upwards, for convenience of reference. The thickness and lithological character of these beds vary somewhat in their different exposures. The position of one or two plant-beds appearing elsewhere at this locality, but not observed

on the line of section, is indicated. I have given lists of all the plants, &c., described, which I have collected from each plant-bed, with some remarks on their mode of occurrence, and I have noticed some of the undescribed species.

The following Section begins at the base of the Dadoxylon Sandstone beds, at their junction with the trappean beds of the Bloomsbury Group, which form the high land skirting the shore to the northward, and takes up the overlying beds in ascending order :—

SECTION OF THE LITTLE RIVER GROUP AT THE "FERN LEDGES," LANCASTER, N. B.

Heavy beds of grey sandstone and flags. Thickness, by estimation, 300 feet.

Dadoxylon Ouangondianum, DAWS.—*Calamites*, &c.

Under this head I have classed all the beds underlying the Plant-bed No. 1, which I am disposed to regard as the lowest of the rich plant-bearing layers, and the base of the Cordaite Shales. These beds occupy the low ground lying between the ridge of the Bloomsbury Group and the shore. They are covered by Drift, and show themselves only in limited outcrops, and in the ledges on the shore. In the western part of the ledges they are thrown forward on the beach by a fault, forming a prominent mass of rock, in the summit of which a fine trunk of *Dadoxylon* is seen imbedded in the sandstone. Recent excavations made in these beds in quarrying stone for building purposes, in the eastern part of the locality, where the rocks are very much broken up by dislocations, have exposed numerous badly preserved impressions of large trunks of this tree.

PLANT BED No. 1. Thickness 1 foot.

Black arenaceous shale, varying from a fissile sandstone to a semi-papyraceous shale, very fine grained and very fissile, charged most richly with beautifully preserved remains of plants, among which are the following species :—

Calamites transitionis, GŒPPT.—Occasional, in large, *erect* specimens.

Asterophyllites latifolia, DAWS.—Extremely abundant, often showing ten or twelve whorls of leaves, sometimes with many branches.

A. acicularis, DAWS.—Also very abundant. I have obtained, since the publication of Dawson's paper, some very fine fronds, showing the mode of branching and the strobilus-like termination of the frond.

? A. longifolia, BRONGNT.—I have, since the appearance of Dawson's paper, collected a fine suite of specimens of the species which he has referred with some doubt to the above, and strongly suspect it to be a distinct species.

? A. scutigera, DAWS.—The curious stems of this species, with their scale-armed nodes, occur abundantly in this bed. The specimen figured in Dawson's paper on the Flora. Dev. Period, N. E. America, Pl. xiii. fig. 19, and which he refers to the apex of this species, came from Plant-bed No. 2, in which I have never detected *A. scutigera*. Stems of this Asterophyllites are not unfrequently found in the sandstone overlying Bed 1 in the eastern part of the Ledges.

Sphenophyllum antiquum, DAWS.—A single specimen of a *Sphenophyllum*, found in a light coloured shale overlying the bed, has been referred by Dawson to this species.

? *Pecopteris obscura*, LESQX.—Ferns are extremely rare in this bed. Dawson has referred with doubt to this species, a single specimen, the only one I have yet found. It is figured in his paper.

Sphenopteris sp?—A delicate little *Sphenopteris*, occurs very rarely in this bed. It may be *S. marginata*; but my specimens are not sufficiently well preserved to enable me to identify it.

Cardiocarpum cornutum, DAWS.—Rare.

Psilophyton elegans, DAWS.—Occasional.

I have never detected any trace of *Cordaites Robbii*, DAWS., in this bed. It is extremely common in the overlying strata.

Grey sandstones and flags, with occasional ill-preserved plants, *Calamites transitionis*, GŒPPT., *Cordaites Robbii*, DAWS.—*Asterophyllites and Sternbergiæ*, 2 feet 6 inches.

Black arenaceous shales of the same character as those of No. 1, but without fossils so far as I have examined,— 11 inches.

Compact, flaggy, grey sandstone, with badly preserved plant remains, *Calamites*, &c.,— 2 feet.

Very soft, dark, lead-coloured shales, much slickensided and charged with fragments of plants. This bed is so soft that the action of the weather and the sea have everywhere denuded it to the level of the beach. 4 feet.

PLANT BED No. 2. 1 foot.

At the point where the section crosses the bed, and where I first discovered it, it consists of very compact and hard, light lead-coloured, slate-like, arenaceous shale; but the character of the shale varies much in its different exposures, being sometimes very soft and fissile, and of a very black colour. The following is the list of species which it affords:—

Calamites transitionis, GŒPPT.—Occasionally; never in good specimens.

C. cannæformis, BRONGNT. " " "

Asterophyllites acicularis, DAWS.—Rather rare.

A. latifolia, DAWS. " "

A. longifolia, BRONGNT. " "

A. parvula, DAWS.—Whorls of a minute *Asterophyllites*, which may belong to this species, are not infrequent in this bed.

Annularia acuminata, DAWS.—I have collected a great number of specimens of this species from Bed No. 2, as well as from some of the overlying plant-beds, where it is very much more abundant; but I have found it to occur invariably in detached whorls. The leaves in a whorl are never spread out in the same plane, as in *A. sphenophylloides* for instance, but are always more or less erect, usually spreading slightly. It is a minute species, the leaves being 1-6—1-5 of an inch in length.

Pinnularia dispalans, DAWS.—Abundant.

Psilophyton elegans, DAWS.—Quite common, always in fragments, never in good specimens.

P. glabrum, DAWS.—Flattened stems, with a wavy woody axis, traced in a brighter line of graphite, occur in this bed, but always in fragments. Dawson refers them with doubt to the above genus. They are not uncommon elsewhere at this locality.

Cordaites Robbii, DAWS.—Extremely abundant, and very fine specimens may be obtained, especially from the upper part of the bed, and rarely specimens showing the base or the apex of the leaf.

Cyclopteris obtusa, LESQX.—Occurs very abundantly in detached pinnules, rarely with several attached to a rachis. The specimen figured in Dawson's paper, Pl. xv. fig. 33, came from this bed, as also did those of the following:—

Cyclop. varia, DAWS.—Rare.

Neuropteris serrulata, DAWS.—Very rare.

N. polymorpha, DAWS.—Extremely abundant, never in large fronds.

Sphenopteris Hæninghausii, BRONGNT.—Quite abundant, often in fine fronds. Is this species specifically identical with the European?

S. marginata, DAWS.—Abundant, in fine fronds.

S. Harttii, DAWS.—Very rare. The original specimen came from this bed.

S. Hitchcockiana, DAWS.—Dawson has suggested that certain minute bodies, which resemble fragments of comminuted leaves, and which are scattered abundantly through the shale of this, as well as some of the other plant-beds, may be the detached pinnules of the above fern. They, however, show no structure, being merely minute rounded or oval patches of graphite, and they have never been found attached to a rachis.

Hymenophyllites Gersdorffii, GŒPPT.—Rather rare. *Hymenophyllites Gersdorffii* is a species occurring in the French coal. I am inclined to doubt whether the New Brunswick species is identical with it.

H. obtusilobus, GŒPPT.—Rare.

H. curtilobus, DAWS.—The specimen on which Dawson founded his species, was obtained from this bed.

Pecopteris (*Alethopteris*) *discrepans*, DAWS.—Amongst all the abundance of plants afforded by Bed No. 2, I have detected only one or two pinnules of this fern, which appears first in abundance in Bed No. 3. It is afterwards one of the most common species.

Pecopteris ingens, DAWS.—Very rare, only two or three fragments of pinnules having been found.

Trichomanites ?—Only a single specimen, probably, as Dawson has suggested, only the skeleton of a fern.

Cardiocarpum cornutum DAWS.—Abundant, and very finely preserved, never attached.

C. obliquum, DAWS.—Quite abundant, also never attached.

Trigonocarpum racemosum, DAWS.—Rare.

Eurypteris pulicaris, SALTER.—The occurrence in Bed No. 2 of this minute Crustacean, was first detected by my friend Mr. George Matthew. It is very rare, not more than four or five specimens having been found by Messrs. Matthew, Payne, and myself, at the time of the description of the species by Salter. I have since that time succeeded in collecting nearly twice as many more, some of which appear to belong to a new species.

Amphipeltis paradoxus, SALTER.—The specimen figured in Salter's paper was found by Professor Dawson and myself, in breaking a piece of shale in my cabinet, that came from this bed. Only one other specimen has since been obtained. It consists of two or more of the thoracic segments, and was collected by Mr. Lunn. It is in the collection of the Natural History Society of New Brunswick. In addition to the above species, this bed has afforded the following as yet undescribed :—

Cyclopteris, sp. nov.—A large *Cyclopteris* occurs not unfrequently in Bed No. 2, although rarely in complete pinnules. It bears some resemblance to *Cyclop. ingens*, L. & H. of the Middle Coal Measures of Grand Lake, New Brunswick. I have lately obtained some fine specimens in sufficiently large number to admit of its description.

Neuropteris, sp. nov.—A single specimen collected by Mr. Lunn. Dawson speaks of it as in some points resembling *N. gigantea*, and says—"It is about an inch in length, broadly oval in form, and with thick and persistent and crowded nervures, forking twice."

Sphenopteris, sp. nov.—A specimen of a *Sphenopteris* was discovered in this bed by my friend Mr. James Hegan of St. John. It was forwarded to Prof. Dawson, but proved too imperfect for description. I have since obtained other specimens, which will enable me to describe it.

Spirorbis, sp ?—The leaves of *Cordaites* in the upper part of the bed, are as thickly covered with a little *Spirorbis* as are the fronds of the recent fucoids of the Ledges. The specimens are too poorly preserved for identification.

Trilobites.—Mr. Payne collected a minute trilobite from this bed. The specimen was sent by Professor Dawson to Mr. Salter, but that gentleman has made no mention of it in his paper.

Insect Remains !—In the Summer of 1862 I discovered an organism in Bed No. 2, which at the time I could make nothing of; but which I have since proved to be the wing of an insect. Several weeks after, I found in Bed No. 8 an unequivocal insect's wing. This discovery was followed by that of others, as I shall have occasion hereafter to relate, my father, J. W. Hartt, finding another in this bed.

Compact flaggy sandstone, quite barren. 5 feet 10 inches.

PLANT BED No. 3. 10 inches.

Black and lead-coloured shales, quite compact in upper part, but in lower very crumbling, splitting irregularly, slickensided, often with polished surfaces, and traversed by thin quartz-veins. These shales are so soft that the sea and weather have everywhere denuded them to the level of the beach. There are now no exposures of the bed workable.

The following are the Fossils which occur in it:—

Calamites transitionis, GŒPPT.—Occasionally.

C. cannæformis, BRONGNT. "

Asterophyllites latifolia, DAWS.—Very beautiful whorls of this plant are very common here, the whorls, though usually detached, being sometimes found united three or four together.

Annularia acuminata, DAWS.—Common.

Pinnularia dispalans, " "

Psilophyton elegans, " Occasionally.

P.? glabrum, " "

Cordaites Robbii, " Extremely abundant, but not so well preserved as in Bed No. 2. Leaves apt to be preserved as polished bands of graphite, with venation obliterated.

Cyclopteris obtusa, LESQX.—Not very abundant.

Neuropteris polymorpha, DAWS.—In beautiful specimens, common.

Sphenopteris marginata, " Not common.

S. Hœninghausii, BRONGNT.—Not common.

Pecopteris (*Alethopteris*) *discrepans*, DAWS.—It was here that I first discovered this species. It occurs quite abundantly, but always in fragments. It was from specimens taken from this bed that Dawson figured and described the species.

Cardiocarpum cornutum, DAWS.—Quite common.

C. obliquum, DAWS.—Quite common.

Coarse sandstone, full of obscure casts of *Sternbergiæ* and *Calamites*,	6 feet	6 inches.
Soft shale and fissile sandstone, with *Calamites*,	0 "	3½ "
Sandstones,	2 "	3 "
Shale, with obscure remains of plants,	0 "	2½ "
Sandstones, barren so far as examined,	4 "	10 "
Sandstone and shale, with a few *Calamites* and *Cordaites*,	0 "	9 "
Sandstone and coarse shale, with obscure markings,	5 "	10 "
Light greenish, coarse shale, with fern-stems, *Cordaites*, and obscure markings, *Carpolites* (?)	0 "	7 "
Sandstones and coarse shales, with badly preserved vegetable remains,	18 "	9 "
PLANT BED No. 4.	1 "	0 "

Coarse shales, affording at the point where the line of section crosses it—

Cordaites Robbii, DAWS.

Calamites transitionis, GŒPPT.

Neuropteris polymorpha, DAWS.

Psilophyton glabrum, "

Pinnularia dispalans, "

I have examined at two different points in the eastern part of this locality, a bed which appears to correspond to this. It is characterized there by a very beautiful *Neuropteris* (sp. nov.) with long linear-lanceolate pinnules decurrent on the rachis, to which they form a broad wing. The pinnules are often four inches in length. This is one of the most beautiful ferns occurring at the locality. Several other new forms are associated with it. Among these is a magnificent *Cardiocarpum*, nearly two inches in diameter.

Sandstone with obscure markings. 0 feet 6 inches.

PLANT BED No. 5. **6 inches.**

Soft, fine-grained, light greenish shale.

Cordaites Robbii, DAWS.—Extremely abundant.

Calamites cannæformis, BRONGNT.—Found occasionally.

Psilophyton ? glabrum, DAWS.

? Asterophyllites acicularis, DAWS.

Pecopteris (*Alethopteris*) *discrepans*, DAWS.—Quite abundant.

Sphenopteris marginata, " "

Pecopteris, sp. nov. ?

Hymenophyllites, sp. ?

Neuropteris polymorpha, DAWS.—Very abundant.

Spirorbis occurs in the bed, attached to the leaves of *Cordaites*. I have never detected it in any of the beds higher up.

Compact flaggy sandstones and coarse shales, with a few plants. 8 feet.

PLANT BED No. 6. 2 feet.

Fine-grained and light coloured shale, with great abundance of *Cordaites Robbii*, and *Calamites transitionis;* above that a layer of coarse shale, with *Cordaites* and stems of plants badly preserved; then a layer of soft, very friable shale, with few fossils; and lastly, a layer of coarse shale of a greenish-grey colour, with—

Pecopteris discrepans, DAWS.—Abundant.

Cordaites Robbii, " "

Calamites cannaeformis, BRONGNT.

Neuropteris polymorpha, DAWS.

Cardiocarpum cornutum, "

Cardiocarpum obliquum, "

Pecopteris, sp. nov.—Occurs abundantly in some of the overlying beds.

Sandstones and coarse shales, with abundance of plant-remains, principally *Cordaites* and *Calamites*. 5 feet.

PLANT BED No. 7. 2 feet.

This is one of the richest plant-beds of the section. The shales composing it vary much in character in different exposures. They are for the most part of a grey colour, and compact, like a fine-grained sandstone, though they pass into a light brownish, very fissile, soft shale, and there are some layers of a very black colour.

Cordaites Robbii, DAWS.—Very abundant, and in a beautiful state of preservation.

Calamites transitionis, GŒPPT.—Not abundant as good specimens.

C. cannæformis, BRONGNT.—Rare.

? Asterophyllites acicularis, DAWS.—In very beautiful specimens, very common in certain thin layers. There are two or three other species, occurring also in the overlying beds, which appear to be new.

Annularia acuminata, DAWS.—Extremely plentiful.

Pinnularia dispalans, " " "

? Psilophyton elegans, DAWS.—I have obtained several specimens of a *Psilophyton*, growing in tufts, and closely resembling this species.

Neuropteris polymorpha, DAWS.—Occasional.

Pecopteris (*Alethopteris*) *discrepans*, DAWS.—Abundant, and obtainable in good specimens.

Cyclopteris obtusa, LESQX.—Occasional.

Sphenopteris marginata, DAWS. "

? Hymenophyllites Hildrethi, LESQX.—Occasional. This delicate little fern, which is very common in the overlying plant-bed, bears a very strong resemblance to *H. Hildrethi*; but it may be new.

Cardiocarpum cornutum, DAWS.—Quite abundant.

C. obliquum, " "

C. sp. nov.—A very elongated species.

Alethopteris, sp. nov.—A new species allied to *A. Serrula*, LESQX., but distinct.

P. (*A.*) sp. nov.—A new species, apparently allied to *P. Miltoni*, shows fructification?

P. (*A.*) sp. nov.—A very beautiful species, occurring in very large fronds. Several other plants not yet determined.

Insects.—A single insect's wing was obtained from this bed by my father and myself.

Compact sandstone and coarse shales. (Barren of fossils.) 3 feet.

PLANT BED No. 8. 1 foot 10 inches.

Fine grained, tough, but fissile sandstones, rather coarse shales, often of a greenish cast, and at the top a thin layer of very black shale, very rich in plants. The middle portion does not contain so many plant remains, but the lower is as well stocked as the leaves of a herbarium. The following are the fossils I have collected from it:—

Cordaites Robbii, DAWS.—As usual in great profusion, and in very fine specimens.

C. transitionis, GŒPPT.—Occasional.

C. cannæformis, BRONGNT. " "

? Asterophyllites acicularis, DAWS.—Quite common, together with one or two other species apparently new, which occur also in Bed 7.

Annularia acuminata, DAWS.—Extremely common, especially in certain layers.

Pinnularia dispalans, DAWS.—Abundant.

? Lycopodites Matthewi, DAWS.—Rare.

Cyclopteris obtusa, LESQX.

Cyclopteris, sp. nov.

Neuropteris polymorpha, DAWS.—Quite frequent in detached pinnules.

? Hymenophyllites Hildrethi, LESQX.—Very common.

Pecopteris (*Alethop.*) *discrepans*, DAWS.—This is the most abundant fern in this bed. It occurs usually in detached pinnules, though not unfrequently in considerable fronds. I have from this bed a frond ten inches long, which I hope to figure.

Pecopteris (*Alethop.*)—Besides the above, there are three or four other species, new, some of which occur also in Beds 6 and 7.

Cardiocarpum cornutum, DAWS.—Not very common.

C. obliquum, DAWS.—Also, " "

C. sp. nov.—The elongated species spoken of in the list of fossils given for Bed 7.—Quite common.

Several other species of plants not yet determined.

Insects.—Two species, two specimens. One was obtained by my friend Mr. James Hegan. Mr. Scudder informs me that all the insect remains from this locality are sufficiently well preserved for determination.

Sandstones and coarse shales, with badly preserved *Cordaites Robbii*, DAWS. *C. transitionis*, GŒPPT., and *Pecopteris* (*A.*) *discrepans*, DAWS. 26 feet.

Fine grained, light-greenish shale, with obscure remains. 1 foot.

Sandstone and shales, with *Calamites* and obscure markings. 23 feet.

This brings up the section to those beds which are exposed within a few feet of low-water mark. Owing to the short time during which the rocks are laid bare by the fall of the tide, to their hardness, and to the way in which they are rounded down by the surf, the work of exploring this part of the section is very difficult, and I have not been able to give them a very close examination.

A very rich plant-bed crops out within a short distance of low-water mark on the very eastern margin of the ledges. Its place in the section is somewhere near Bed 8. It is characterised by *Cyclopteris valida*, DAWS., which appears to be limited to it. The unique specimen figured in Dawson's Paper "On the Flora of the Devonian Period, &c.," Plate xvii. fig. 52, came from this bed. I obtained here a magnificent frond of *Neuropteris polymorpha*, DAWS., showing its structure finely, and the different forms of the pinnules in different situations on the frond. Many of the species common in the underlying beds are also to be found in this; but I am unable to give a complete list.

Total thickness of the Beds embraced in this Section, 444 feet, 11 inches.

Cambridge, Mass., December, 1864.

Since the above was written, I have received the following letter from Mr. Scudder, relating to the fossil Insect-remains.

Boston Society of Natural History,
Berkeley, corner of Boylston Street, January 11, 1865.

MY DEAR MR. HARTT,—I have made as careful an examination as my present circumstances will permit, of your most interesting collection of the fossil remains of insect-wings from Lancaster. There are ten specimens in all, eight of which are reverses of one another, thus reducing the number to six individuals; of these, one, a mere fragment, belongs, I think, to the same species as another of which the more important parts of the wing are preserved, so that we have five species represented among these Devonian Insects, and these remains are all, I suspect, composed of portions of the anterior wing alone. The data being thus fragmentary, the conclusions cannot be quite so satisfactorily determined as we could wish, but we can still discover enough to prove that they are of unwonted interest. Besides the peculiar interest which attaches to them as the *earliest known traces* of *insect life on the globe*, there is very much in themselves to attract and merit our closest attention.

One of them is a gigantic representative of the family of *Ephemerina* among Neuroptera, some three or four times the size of the largest species now living, with which I am acquainted.

Another borrows some striking points of the peculiar wing-structure of the Neuropterous family *Odonata*, and combines with them those of families remote from that, and even belonging to a distinct section of the Neuroptera, exhibiting to our view a synthetic type which combines in one the Pseudoneuroptera and the Neuroptera, and represents a family distinct from any hitherto known.

Other fossil insects, found in carboniferous concretions in Illinois, and described in Silliman's Journal, (N. S. xxxvii, 34), which Professor Dana has kindly allowed me to examine,* also belong to hitherto unrecognized families, exhibiting similar relations to these in-our-day-disconnected Sections of Neuropterous insects; and your third species is a member of still another family of Neuroptera, which finds its natural relations between the two described by Professor Dana.

A fourth, of which only an unimportant fragment was found, would seem to belong to the Neuroptera; but by some peculiarities of the minuter cross-veins, thrown off in the middle of the outer edge of the wing, in a most irregular and unusual manner, suggests no intimate relations with any known family, but must have belonged to a group of large and weak-winged insects.

* The results of this examination will shortly be communicated to Silliman's Journal.

The fifth and last to be mentioned is of very striking interest, because, while it exhibits the peculiar venation which forms the well known tympanum or stridulating apparatus of the male, in the Orthopterous family *Locustariae* (though differing somewhat from that), it also most resembles the Neuroptera in all or nearly all the other peculiarities of its structure, and suggests the presence in the insect-faunæ of those ancient times of a synthetic type, which united the characteristics of the Orthoptera and Neuroptera, in themselves closely allied; this point however requires patient and severe investigation, and only my earliest impressions are here recorded, made however immediately after a close examination into the relations of other fossil insects.

I earnestly hope that this locality, from which these remains were disinterred, may receive a most careful and thorough examination by yourself, who have already shown so much diligence and careful scrutiny in the discovery of such important and easily overlooked remains. Hitherto, the study of fossil insects has been mainly confined to those of much more recent date, and has resulted in shedding comparatively little light upon geological and palæontological questions; but these few remains, coupled with the pair of insects found in Illinois, induce us ardently to anticipate that the future study of fossil insects, drawn from such ancient strata as these, may lead to as brilliant and important results, in the elucidation of geological problems still open, in widening the range of our palæontological horizon, and in our general knowledge of the history of Life on our globe in all its bearings, as have been reached by the study of the remains of animals of a more substantial structure, but which have hitherto been denied to the student of fossil Entomology.

With many thanks to you for the opportunity of an inspection of these relics, to which so strong an interest attaches, and hoping soon to give you a more detailed and satisfactory report,

I remain, very sincerely yours,

SAM. H. SCUDDER.

APPENDIX B.

LIST OF NEW BRUNSWICK FOSSILS.

By C. Fred. Hartt, A. M.

The following list of Fossils comprises all the species ascertained to exist in the Province. A large proportion of these, principally plants, have been accurately determined, thanks to the labours of the distinguished Dr. Dawson, to whom Acadian Geology and Acadian Geologists owe almost everything. The list is of course very incomplete; but it will serve to show what little has been done in the study of the Palæontology and Fossil Botany of New Brunswick, and the extent of the field yet unexplored that invites the researches of the Palæontologist and Fossil Botanist. It has afforded many treasures, and there is promise that the future explorer will not go unrewarded.

The materials for this list were collected from the following sources:—

Dawson's "*Synopsis of the Flora of the Carboniferous Period in Nova Scotia*," in which a number of species of Carboniferous plants from several localities in New Brunswick are given, a few being new.

Dawson's "*Flora of the Devonian Period in N. E. America*," from which was taken the list of described Devonian plants.

The papers of Dawson, Salter, Matthew, and Jackson, relating to the geology or Palæontology of the Province. For the list of *post-tertiary* forms I am largely indebted to my friend Mr. Matthew. The rest of the list is made up from my own notes.

Quite a number of New Brunswick Fossils are mentioned in Gesner's Report, but his determinations are not trustworthy, and I have included none of them in this list.

I. Post Tertiary.—Marine Clays.

Articulata.

Balanus Hameri, Lawlor's Lake.
B. crenatus, " "

Mollusca.

Pecten Islandicus, *Ch.* Lawlor's Lake, R. R. Depot, Saint John.
P. tenuistriatus,
Mytilus edulis, *Linn.* " " " "
Cardium pinnulatum, *Con.* " " " "
Tellina Grœnlandica, Lawlor's Lake, &c.
T. calcarea, Duck Cove, &c.

Leda Jacksoni, Lawlor's Lake.
L. truncata, Duck Cove; Lawlor's Lake; R. R. Depot, Saint John.
Nucula antiqua, " " " " " "
Mya arenaria.
M. truncata, " " " " " "
Aphrodite Grœnlandica, Duck Cove, &c.
Cardium Islandicum, *Linn.*
Mesodesma, R. R. Depot.
Saxicava distorta, *Say.*
Lyonsia arenosa, Duck Cove.
Lacuna neritoidea, *Gould*, Duck Cove.
Pandora trilineata, "
Natica clausa, *Sow*, "
Buccinum undatum, *Linn*, Duck Cove.

Bryozoa, several species undetermined, Taylor's Island, Lawlor's Lake, &c.

Radiata.

Ophiurans, two species, Saint John, Duck Cove.
Toxopneustes drobachensis, (Echinus granulatus,) Red Head, Lawlor's Lake.

Plants.—Algæ, three species, undetermined.—Manawagonis.

N. B.—Beside the above Mollusca, there are in Mr. Matthew's hands twenty or thirty additional species, not yet determined.

II. New Red Sandstone.

For remarks on the only fossil of this age see Report, page 124.

III. Carboniferous Epoch.

a. Upper Coal Formation.—(*Dawson.*)

Plants—Described Species.

Dadoxylon materiarium, *Dawson*, Miramichi.

b. Middle Coal Formation.—(*Dawson.*)

Animals.

The only animal I have seen from the Middle Coal Formation is a little Spirorbis, resembling *S. Carbonarius*, which occurs attached to plants in the roof-shales of the Coal-Seam at Coal Creek, Newcastle, Grand Lake. *Coprolites of Fishes* are found in the same shales.

Plants—Described Species.

Dadoxylon Acadianum, *Dawson*, Dorchester.
Calamodendron approximatum, *Brongnt.* Coal Creek, Grand Lake.
Antholites rhabdocarpi, *Dawson*, " " " "
Calamites Suckowii, *Brongnt.* " " " " Gardner's Creek.
C. Cistii, *Brongnt.* " " " " Baie de Chaleur.
C. nodosus, *Schlot.* " " " "
C. cannæformis, Gardner's Creek.
Asterophyllites grandis, *Sternberg.* Coal Creek, Grand Lake; Baie de Chaleur.
Annularia galioides, *Zenker*, " " " " " "
Sphenophyllum emarginatum, *Brongnt.* " " " " "
S. saxifragifolium, *Sternberg.* Baie de Chaleur.
Cyclopteris (Nephropteris) obliqua, *Brongnt.* Coal Creek, Grand Lake.
C. (? Neuropteris) ingens, *L. & H.* " " " "

Neuropteris rarinervis, *Bunbury*, Coal Creek, Grand Lake; Baie de Chaleur.
N. gigantea, *Sternberg*, " " " "
N. Loshii, *Brongnt.* Gardner's Creek ? Baie de Chaleur.
N. auriculata, " "
Odontopteris Schlotheimii, *Brongnt.* Baie de Chaleur.
Sphenopteris munda, *Dawson*, Coal Creek, Grand Lake.
S. latior, *Dawson*, " " " "
S. gracilis, *Brongnt.* " " " "
S. artemisifolia, *Brongnt.* " " " "
S. Canadensis, *Dawson*, Baie de Chaleur.
S. obtusiloba ? *Brongnt.* " "
Alethopteris lonchitica, *Sternberg*, Coal Creek, Grand Lake.
A. nervosa, *Brongnt.* Baie de Chaleur.
A. muricata, *Brongnt.* Bathurst.
A. pteroides, *Brongnt.* "
A. Serlii, *Brongnt.* Baie de Chaleur.
A. grandis, *Dawson*, "
Beinertia Gœpperti, *Dawson*, Coal Creek, Grand Lake; Baie de Chaleur.
Palæopteris Harttii, *Dawson*, " "
Lepidodendron Pictoense, *Dawson*, " Newcastle River, Grand Lake.
Lepidostrobus squamosus, *Dawson*, " " "
Cordaites borassifolia, *Corda*, " " "
C. simplex, *Dawson*, " Baie de Chaleur.
Cardiocarpum bisectatum, *Dawson*, " Newcastle River, "

Undescribed Species.

Nœggerathia, sp. nov. *Dawson*, Baie de Chaleur.
Halonia ? sp. ? *Dawson*, Coal Creek.

c. *Lower Coal Formation.*—(*Dawson.*)

Animals.—The Fauna of the Carboniferous limestone in New Brunswick, though rich in species, has not yet been touched by the palæontologist, and all the species are still undetermined. A small collection of my own, from Ocnabog Lake, and a suite of specimens collected at various localities during the past summer by Professor Bailey, will enable me, while preparing a lengthy Monograph of the Carboniferous Limestone fossils of Nova Scotia, to do something towards exploring this new field, and towards settling the age of the Acadian Carboniferous limestone, concerning whose exact equivalency I now entertain some doubt. The majority of the New Brunswick specimens I have had the opportunity of examining, occur also at Windsor, Brookfield, and elsewhere in Nova Scotia. The genera comprise *Productus, Terebratula, Spirifer, Athyris, Macrodon, Aviculopecten, Conularia, Naticopsis, Nautilus, Orthoceras*, &c.

The very interesting fish-fauna of the Albert shales is not yet worked up. Dr. C. T. Jackson has named and described a few of the species in his Report on the Albert Coal Mine; but his descriptions are very unscientific and altogether unsatisfactory. His named species are the following:—

Palæoniscus Alberti, *Jackson*, Albert Mines.
P. Brownii, *Jackson*, "
P. Cairnsii, *Jackson*, "

IV. Devonian.

a. Little River Group.—(Upper Devonian.)

Animals—Described Species.

The only animal remains described from the Little River Group are the two Crustaceans;—

Amphipeltis paradoxus, *Salter*, Fern Ledges.

Eurypterus pulicaris, *Salter*, "

Undescribed Species.

All the undescribed species belong to the Branch of Articulata, and comprise representatives of its three classes.

Insecta.

Five genera, five species, nov. Fern Ledges.

Vide Letter from Mr. Scudder, Appendix A.

Crustacea.

Eurypterus, sp. nov.? Fern Ledges.

Phillipsia? sp. nov? " vide Dawson "on the Flora of the Devonian Period in N. E. Amer." p. 303, Note.

Vermes.

Spirorbis, sp? Fern Ledges.

Plants—Described Species.

Dadoxylon Ouangondianum, *Dawson*, Little River; Point below Barracks, St. John; Fern Ledges, Lancaster.

Sigillaria palpebra, *Dawson*.

Stigmaria ficoides, (var.) *Dawson*, Calamites Ledges, Lancaster.

Calamites transitionis, *Gœppt.* Calamites Ledges, Fern Ledges, Saint John, Little River; Mispeck Bridge on Black River Road.

C. cannæformis, *Brongnt.* Localities same as preceding.

Asterophyllites acicularis, *Dawson*, Fern Ledges.

A. latifolia, *Dawson*, "

A. scutigera, *Dawson*, "

? A. longifolia, *Brongnt.* "

A. parvula, *Dawson*, " Saint John.

Annularia acuminata, *Dawson*, " Little River.

Sphenophyllum antiquum, " Saint John.

Pinnularia dispalans, *Dawson*, " " Little Riv. Calamites Ledges.

Lepidodendron Gaspianum, *Dawson*, Calamites Ledges.

Lycopodites Matthewi, *Dawson*, Fern Ledges, Saint John.

Psilophyton elegans, *Dawson*, "

P. glabrum, *Dawson*, " Calamites Ledges.

Cordaites Robbii, *Dawson*, " Calamites Ledges; Saint John; Little River; Mispeck River Bridge on Black River Road.

C. angustifolia, *Dawson*, Saint John.

Cyclopteris Jacksoni, *Dawson*, Saint John.

C. obtusa, *Lesqx*, Fern Ledges, Little River.

C. varia, *Dawson*, "

C. valida, *Dawson*, "

Neuropteris serrulata, *Dawson*, Fern Ledges.

N. polymorpha, *Dawson*, Fern Ledges; Little River; Calamites Ledges; Saint John; Mispeck.

Sphenopteris Hœninghausii, *Brongnt.* Fern Ledges.
S. marginata, (*Dawson,*) Fern Ledges.
S. Harttii, (*Dawson,*) " "
S. Hitchcockiana, *Dawson*, Fern Ledges, Little River, Calamites Ledges.
Hymenophyllites Gersdorffii, *Gœppt.* Fern Ledges.
H. obtusilobus, *Gœppt*, " ".
H. curtilobus, *Dawson*, " "
Pecopteris (Alethopteris) discrepans, *Dawson*, Fern Ledges, Little River, Calamites Ledges, Saint John.
P. (A.) ingens, *Dawson*, Fern Ledges.
P. (A.) obscura, *Lesqx.* " "
Trichomanites? " "
Cardiocarpum cornutum, *Dawson*, Fern Ledges, Little River, Calamites Ledges.
C. obliquum, *Dawson*, Fern Ledges.
Trigonocarpum racemosum, *Dawson*, Fern Ledges.

Undescribed Species.

In addition to the above species, I have in my hands for determination about twenty-five more, the majority of which are new. They belong to the genera *Asterophyllites*, *Cyclopteris*, *Neuropteris*, *Sphenopteris*, *Hymenophyllites*, *Pecopteris*, *Alethopteris*, *Cardiocarpum*. —(*Vide* Appendix A.)

V. Silurian.

a. Primordial.

The fauna of the Primordial in New Brunswick comprises, so far as is now known, about 17 species of Trilobites and Brachiopoda, all of which are new, and will be figured and described in a paper which I have in course of preparation, but whose publication may be delayed for a short time, until further material shall have been collected, so that all the species may be satisfactorily illustrated. (*Vide* "Preliminary Notice," pp. 30, 31, of this Report.)

The following is the list of the genera, with the number of species in each :—

Paradoxides,	5 sp. nov.	Orthisina,	2 sp. nov.
Conocephalites,	7 "	Discina,	1 "
Agnostus,	1 "	Obollella,	1 "
Genus nov.	1 "	Lingula,	2 "

The localities are Ratcliffe's Millstream and Coldbrook.

Cambridge, February 14th, 1865.

Note.—In the above list by Mr. Hartt, no reference has been made to the rich fossiliferous limestones of Restigouche County, probably for the reason that the numerous remains which they contain, though finely preserved, have not yet received any thorough or careful examination. While, however, this uncertainty exists as to the particular species afforded by the locality, it may not be out of place to mention the names of those genera believed to occur in the beds referred to. They are as follow :—

Favosites (Gothlandica et basaltica ?), Syringopora, Cyathophyllum, Orthis, Strophomena (Leptæna depressa et L. euglypa), Murchisonia, Zaphrentis, Cyclolites, Atrypa, Avicula, Litoites, Turbinolopsis and *Stems of Encrinites.*

A boulder with a finely preserved *pygidium* of a Trilobite (a species of *Dalmania*), and another covered with the chain-coral (*Halysites*) have been found in the same district, but from what beds they were derived is unknown.

Beside the above-named Silurian fossils, there are in the University collection many other forms from various localities not mentioned in the foregoing list, among others marine shells from the clays of Saint Andrews and Bathurst; *Sigillariae, Stigmariae, Calamites*, &c., from various parts of the Coal Field; and obscure plant-remains from the Devonian rocks of Charlotte.—*L. W. B.*

APPENDIX C.

CUPRIFEROUS ROCKS OF SOUTH-EASTERN NEW BRUNSWICK,

COMPARED WITH THOSE OF THE EASTERN TOWNSHIPS, CANADA.

By Geo. F. Matthew, Esquire.

[Read before the Natural History Society of New Brunswick, 4th February 1865.]

There are few readers of the public prints who have not learned of the famous Acton Copper Mines and the Chaudiere gold region of Canada, though perhaps many are not aware of the inexhaustible mineral wealth existing in that part of Lower Canada known as the "Eastern Townships."

Extensive stores of knowledge on this point may be found in the Report on the Geological Survey of Canada (1863). From this work, where the geology of this region is elaborately and systematically detailed, I make some gleanings.

The sediments of the region in question belong principally to the Quebec Group of Canadian geologists, which Mr. Billings has shown to be equivalent to the Calciferous and Chazy formations of New York and Western Canada.

"The lower division of the group appears to be supplied with ores of "iron, lead, zinc, copper, nickel, cobalt, chromium, and titanium, as well "as with silver and gold. Some of these are known to exist in quantities "economically available, and others will hereafter probably be found to be so.

"This portion of the group abounds also, in its more altered portions, in "roofing slates, serpentine, soapstone, potstone, whetstone, magnesite and "dolomite.

"The country over which the group is distributed is a mining region of "much importance.

"What is considered the upper portion of the group, composed of the "Sillery sandstones, does not appear to be in any remarkable degree metal-"liferous, nor is it yet certain whether the more valuable metals abound in "the dark shales which are at the base of the group.

"This whole series of rock, however, occupies a place which brings it to "the horizon of the upper copper-bearing series of Lake Superior."

In the metalliferous district of the Eastern Townships, the lower division of the group would appear to consist of grey clay slates, with thick beds of felspar rock, which in some places have the appearance of coarse-grained sandstones—succeeding these a great mass of magnesian strata with micaceous slates and sandstones (the most highly metalliferous portion of the group)—and lastly red shales connected with the upper portion of the group (Sillery sandstones). A great part of the copper ores occur in *fahlbands* (or metalliferous layers) in chloritic slates and limestone. The serpentines,

with which ores of magnetic and chromic iron are associated, are said to represent the dolomites, in an altered condition. Owing to their pearly aspect, the micaceous slates of this group have heretofore been looked upon by New England geologists as *talcose* schists or slates, but Dr. T. Sterry Hunt has by analysis found them to consist of a hydrous mica, mingled with silica in a finely divided state, and proposes for rocks of this description the term *nacreous* slates.

Having glanced at some features of the Quebec Group, let me now call attention to certain resemblances in lithological characters presented by the metalliferous strata of the coast series in Southeastern New Brunswick.

In a hurried descent of Little Salmon River and passage along the coast to Point Wolf in Albert County, I was enabled to gain a general idea respecting the character and distribution of the rocks alluded to. Here they cover a greater extent of country than further west, owing to two or more synclinal and corresponding anticlinal folds.* From the Shepody road south to the coast, they occupy a tract of elevated land ten miles wide and thirty in length, covered with wood and uncultivated.

Along the road alluded to gneissoid rocks are associated with the slates, and probably represent the granitoid sandstones found near the base of the series at Black River. Slates with a micaceous or talcoid aspect, together with chloritic slates and grits, come out upon each side of Little Salmon River at and below a bridge about eight miles from the mouth, and reappear with reversed dip along the coast. In the synclinal trough intervening, are grey clay slates or argillites, with beds of diorite, and overlaying these a thick deposit of cherty slates.†

In the lower portion of the series, exposed in cliffs and abrupt hills along the coast, copper ores have been met with at a number of places (specified in the body of the Report,) usually in veins, but sometimes disseminated in lumps or grains, in layers of the slate forming *fahlbands*. The deposit at the mouth of Little Salmon River is of this kind, and the character of one of those at the Vernon mine, which yielded gold to the value of $22 per ton of ore, seems to indicate that it also is a *fahlband*. A more interesting locality is that at Black River, where the remains of Devonian vegetation are found associated with copper pyrites in the same bed, in a manner similar to a carboniferous deposit at Bathurst, and indicating that the copper had been thrown down from a chemical solution, in the way in which Dr. Hunt supposes the ore beds of the Quebec Group to have originated.

Suspecting that the slates of Black River, called "talcose" by Dr. Gesner, and which I found to be altered equivalents of the argillo-micaceous slates of Mispeck, were really of a different character, I submitted specimens of them to Drs. Dawson and Hunt, who pronounced them to be "micaceous slates."

* One of these folds (anticlinal) at the river alluded to, dips at a large angle to the northeast, and to this fold, or the synclinal northward, is probably due the course of the main stream of Lower Salmon River.

† The position of these, as well as their character, render it probable that the Mispeck Group is represented by these upper rocks, the strata of both districts being marked by beds of igneous origin at the base, and the cherty slates may answer to the fine clay slates of the highest Devonian rocks.

Similar slates, with talcoid laminæ, of various shades from cream-colour to lilac and purple, which agree in outward appearance with the nacreous slates of the Quebec Group, occur on Little Salmon River and along the coast to Point Wolf. In these and the chlorite slates and grits of the same district, the most important ore-beds and veins of copper ore have been found. Specular iron ore is so abundant in some of these slate rocks, as to give them the character of specular schists. Dr. Gesner speaks of great masses of serpentine in connection with the "older slates and limestone" of this region; adding another to the points in which these rocks resemble those of the Quebec Group.

Magnetic and chromic iron ores may be looked for in these ophiolites. Slates suitable for roofing are said to exist in the rocks of the coast series at Shepody.

The principal difference between this formation and the great metalliferous group of Canada, appears to be the greater abundance in the latter of calcareous and magnesian deposits.

The activity of volcanic agencies in Southeastern New Brunswick at the period when the older strata which border the northern shore of the Bay of Fundy were produced, has already been noticed in the preceding Report; and to this cause the promising character of Albert and the eastern part of Saint John County as a field for mining operations, may in part be due.

But while we note the resemblance in the character of the slates and altered (granitoid) sandstones, as well as the cupriferous deposits of the two series, we do not infer that they were formed at the same period, but on the contrary believe that they are separated in time by the vast accumulations of the Middle and Upper Silurian, and Lower Devonian periods.

The grounds upon which this opinion is based may be shortly stated as follows:—

1. The strata of the Black River Settlement and West Beach are known to be Upper Devonian (Cordaite Shales).

2. The conglomerates at the base of these shales have been traced eastward into the high lands which approach the coast beyond Quaco, and at Lower Salmon River.

3. Strata similar to those of West Beach were found along the course of Little Salmon River, and extend thence eastward to Albert County.

An examination of the mineral resources of the country where these rocks occur, will be attended with some difficulty, owing to the almost unbroken forest which covers them. Still, even a partial exploration may result in the discovery of metalliferous deposits at present unknown; and will at least be the means of collecting a fund of information invaluable to those interested in mining operations in that quarter.

A
n.
:d
U
est
and
ro
Tl
E
T
ua
fr.
lar
lan
nce
Pr
Sa
ral
igd
ara
ysta
ne
We
th
igh
th
rth
Upp
hly
esti
re
r
the
oc

APPENDIX D.

NOTES ON THE GEOLOGY OF CHARLOTTE COUNTY.

By Geo. F. Matthew, Esq.

(Read before the Natural History Society of New Brunswick, February 3rd, 1865).

At Professor Bailey's request, I have thrown together the following remarks, embodying a few observations made by us in Charlotte County, and some general views on the geology of that portion of the Province.

Upper [and Middle?] Devonian.—Besides the strata of this age in south-western Saint John County, described in the body of this Report, and the sandstones of Saint Andrews referred to this age by Dr. Dawson, there are two or three small areas in Charlotte covered by the rocks of this formation.

The first of these is a ridge of conglomerates, &c. extending easterly from L'Etang river, along the coast to Dead Man's Harbour.

The promontory (Point Midjic) on the south side of the entrance to Magaguadavic Harbour, is also (according to information given to Prof. Bailey by Mr. Frye) composed of red Devonian sediments. Several of the smaller islands in Passamaquoddy Bay are of similar origin; and a chain of small islands in the Bay of Fundy, called "The Wolves," are probably of this age, since Dr. Gesner states that they are composed of conglomerate and trap.

Professor Bailey examined the country along the road from Magaguadavic to Saint Andrews. He found the Devonian rocks extending in several parallel ridges, having a northwest course, from Troak's Mountain to the Digdeguash River. Between these points the rocks are all of a trappean character. At the former place are dark coloured claystone-porphyry, (with crystals of red felspar) and amygdaloid; while towards the River last mentioned, red compact felspar and syenitic trap prevail.

West of the Digdeguash, purple sandy shales and sandstones are associated with the traps, and were found to extend as far as Chamcook, where the bright red sandstones of Saint Andrews terminate. These have in general a southerly inclination of 20°; but the purple sediments and trap beds to the north and east, usually tilted in the same direction, are more irregular in dip.

Upper Silurian.—A great part of the older rocks of this County are highly altered, and the determination of their age is therefore a perplexing question. The strata noticed under this head may prove to be in part either above or below this horizon.

In remarks on the age of the Kingston rocks, it was stated that in the southeastern part of Washington County, Maine, there is an extensive district occupied by Upper Silurian sediments, having a breadth of about twenty miles. A large part of them are metamorphosed and injected with masses

of trap; but around Cobscook Bay they are less altered, and contain organic remains of Upper Silurian age. This formation, if it extends into New Brunswick, should pass through the islands which separate Passamaquoddy Bay from the Bay of Fundy, and enter Charlotte County at Magaguadavic, L'Etang, and Beaver Harbour.

On some parts of this shore the older series is obscured by the Devonian rocks of later origin, already noticed; but at those points along the coast where the latter do not occur, slates, trap rocks and limestones, similar to those of the Maine shore and Passamaquoddy islands, are found. As the mines and mineral localities of these slates and limestones are described in detail, in the Report presented to the Legislature at its last Session by Prof. Bailey, it is unnecessary for me to allude to them further in this connection.

While at New River last summer, I made an examination of the strata along this stream, from its mouth to a point eight or ten miles inland. The rocks were found to be similar to those observed by Dr. Gesner along the coast from L'Etang to Mace's Bay. They do not agree in all particulars with the formation at Saint George and L'Etang, but may be in part the same series more highly altered. They consist chiefly of schistose gneiss, passing on the one hand into hornblende schist, and on the other into slaty compact felspar, or more rarely into mica schist; altered clay slate, cherty slate, and silicious mica slate, are of less frequent occurrence. At the river's mouth the strata are somewhat chloritic, and towards the interior the stratification of the gneissoid beds becomes more obscure, and ridges or beds of syenite and granite appear. These granitoid rocks are probably altered sandstones and grits, for at a cliff on the east side of the stream, a bed of granite, two or three feet thick, was seen resting upon slate, and overlaid by similar schistose beds obliquely laminated.

The inclination of this series is S. S. E. 40°–60°. There is a fold in the strata a short distance below the falls, but the thickness of the beds must nevertheless be great.

For seven miles from the coast the country is comparatively level, and is extremely desolate in aspect, being almost entirely destitute of trees, covered in part by peat bogs, and elsewhere by a meagre, sandy and unproductive soil. Further inland a range of hills of the granitoid rocks above alluded to, cut through by this and the neighbouring streams, partially conceals a distant range of mountains.

The gneissoid rocks of New River resemble those of Kingston, but the diorites which abound in the latter are of less frequent occurrence here. If they are really the same formation, as seems probable, the range of hills through which the River passes may correspond to those on the north side of the Reach below Oak Point, while the more distant mountains will be a continuation of the granite eminences which extend across the River from Hampstead above the Reach.

On the northern flank of these mountains there is a belt of arenaceous shale (grauwacke slate of Gesner), usually of grey colours with a tinge of

green or blue. The mica schists observed by Prof. Bailey on the River Saint John at Hampstead, in Queen's County, are probably the same rocks in a more altered state. Eastward of Grand Lake, in the same County, and towards the centre of the great interior coal field, micaceous shales project through the horizontal carboniferous strata. They were examined by my brother (C. R. Matthew) several years ago, who speaks of them as follows:—

"Three miles above Hughson's Mills on Coal Creek, the Coal Measures overlie unconformably a large deposit of bluish silvery-grey slate and shale; the layers of the former (Coal Measures) horizontal or nearly so; those of the latter dipping S. by E. 50°.

The Coal Measures exposed here consist of—

Slaty grey sandstones, ...	2 or 3 feet.
Rubbly purple shales, ...	8 or 10 feet.
Grey slaty sandstones, ...	12 feet.

The upper sandstone contains Calamites and Sternbergiae."

The discovery of this *Island in the Carboniferous sea* gives countenance to the view now generally entertained, that the Coal Measures in this section of Acadia are of no great thickness.

To the westward these shales probably extend into the wilderness country in the northeastern part of Charlotte. To the southwest they may be represented by the red granite rocks of the Magaguadavic and Digdeguash Rivers, similar red felspar rocks being associated with the Upper Silurian shales in other parts of Acadia, as the high table land in the northern part of Cape Breton, and the elevated mountainous district at the sources of the Tobique, Nepisiguit, and Upsalquitch Rivers. To this band of arenaceous shales we are inclined to refer certain fragments of slate of similar texture and colour, occasionally met with in the drift at Saint John. They yield the following organic remains:—

Chonetes, resembling *C. Nova Scotica*, but having long slender spines at the hinge line; *Clidophorus; Cypricardinia* or *Orthonota; Rhynconella* (?); *Orthis; Leptodomus* (?); *Pterinia* or *Avicula; Encrinal joints;* and, on the finer layers, long flexuous impressions, which may be sea-weeds.

Lower Silurian.—A wide belt of slates, admitted by all observers to be of great antiquity, and which will probably prove to be a mining region of much importance, passes through the central part of York County, and the western portion of Charlotte, into the neighbouring State of Maine. Both Drs. Gesner and Robb denominated them Cambrian; but as this term is now restricted to a series of sediments considered by the best English geologists to be equivalent to the Huronian of Canada—a formation known to lie beneath the true Lower Silurian,—it will not be sufficiently accurate, if they should prove to be of the latter age, as we suppose they will. They do not assimilate in physical characters to the known Acadian equivalents of the Cambrian or Huronian series, (see Coldbrook Group in Report), and we found that a collection of rocks of this formation in the University of

New Brunswick, made principally by the late Dr. James Robb, consisted mainly of dark coloured quartzites, and pale green clay slates, the former intercalated with the slates in numerous beds of from one inch to many feet in thickness, thus resembling the strata of the Saint John Group (Lower Silurian,) and differing from the Upper Silurian and [Middle? and] Upper Devonian deposits which have been recognized in this region.

Moreover, the slate formation in question contains beds of glossy plumbaginous schists, which may correspond to the carbonaceous shales of the Saint John group. This latter formation is now known to be equivalent to the Potsdam, together with the Calciferous (and perhaps the Chazy) formations of the New York Geologists, so that we are not inclined to adopt Prof. Hitchcock's surmise, that "it would not be strange if the name Cambrian, which was applied to both these belts of mica-schist in New Brunswick many years ago, and is now generally discarded, should ultimately prove to be their correct appellation." The antimony mines occurring in this serious at Prince William, are described in the Report of last year. Molybdenite, a mineral found in loose pieces at Saint Stephen, Fredericton, and Bathurst, has probably been derived from it. We observed no mica-schist in the University Collection from these shales, although their extension into Maine is described by Professor Hitchcock as a mica-schist formation. This gentleman remarks of the mica-schists on the western border, that they extend along the course of the Saint Croix River, from the lower end of the Chepedneck Lakes to a point on the river two and a half miles from Saint Stephen, being there met by the syenite and granite previously described as extending through the country from the Nerepis River. "In the space (along the Saint Croix) just alluded to, there are two synclinal and three anticlinal axes. The low land soils of this district are invariably very good. That of the high lands may be compared to that between Bangor and Charleston." He also adds:—"The finest auriferous belt brought to light the past season, crosses the Saint Croix River above Calais. The rock is a mica-schist full of quartz veins and beds. An examination of these veins near the railroad bridge in Baileyville, showed us several pieces of bright flake gold. The best locality is on the west side of the river, upon some ledges through which a passage for the railroad has been excavated." "Across the river in New Brunswick, upon land of Mr. Bolton, of Saint Stephen, is another locality where gold has been found. Its distance from Sprague's Falls (railroad bridge) cannot be very great, as it is about nine miles northwest from the Calais bridge. The exact locality of the gold is in a plumbaginous slate, very black and greasy. Near it is a large boss of quartz, with sub-veins of quartz running through it; and there are also near by veins of quartz containing pyrites. These two localities are the most promising of any seen by us in the Saint Croix country."

It will be observed that in the alternations of arenaceous and dark coloured clay slates and intercalated quartzites, this formation resembles the gold-bearing series of the Atlantic coast of Nova Scotia, long ago recognized as Lower Silurian by Dr. Dawson.

If both prove to be on the same geological horizon as the Saint John Group, (viz. Potsdam, Calciferous, &c.) our knowledge of the age and relations of the older metamorphic rocks of Acadia will be placed on a firmer basis than heretofore.

NOTE ON THE FOSSILS FROM FRYE'S ISLAND.*

I have made a hasty examination of the specimens forwarded by Mr. Frye, and find that they tend to confirm the views already expressed regarding the age of the rocks in the central and eastern part of Charlotte County.

Owing to the great distortion of many of the forms, and the small amount of material sent, I cannot speak confidently as to the presence of several genera mentioned below.

Dalmania, *Phacops*, *Orthoceras*, 2 sp. (?); *Murchisonia*, 2 sp.; *Loxonema*, *Holopea* (?), *Lucina* (?) or *Anatina* (?), *Avicula* (?), *Leptodomus* (?), *Spirifer*, *Chonetes* (?), *Atrypa*, *Rhynconella* (?), *Retzia* (?), *Strophomena*, *Orthis*, *Discina*, *Favosites*, *Zaphrentis*, 2 sp.; *Syringopora* (?); and there are also numerous joints of an *Encrinite*.

Among these trilobites, shells and corals, there were no broad-winged Spirifers, and the assemblage of genera seem to me to indicate a Middle or Upper Silurian age, but I am not sufficiently familiar with the organisms of these formations to speak with confidence on this point. The rock in which they occur is a shale alternating with calciferous sandstone and limestone, all very hard and full of joints.

APPENDIX E.

DUNSINANE COAL.†

[Read before the Nat. Hist. Society of N. B. 3rd February 1865.]

The members of this Society are probably familiar with the appearance of this mineral, of which a small quantity has been mined and brought to the City for trial. It is a somewhat impure variety, having layers of bituminous shale intercalated with the coal. In composition it approaches the Springhill coal of Cumberland County, Nova Scotia, as will be seen by the following analysis:—

* See Report, page 39. These fossils reached us at too late a date to allow of their complete determination.

† This seam is on or near land owned by Messrs. Light, Murdock, and Shives.

	Dunsinane.	Springhill.*
Moisture, ...	1.3	1.8
Volatile combustible matter, ...	28.9	28.4
Fixed Carbon, ...	52.9	56.6
Ash, ...	16.9	13.2
	100.0	100.0

Specific gravity of Dunsinane Coal, ... 1.466.

As the sample was taken from near the surface, a few per cent. in addition to the "Volatile matter" and "Fixed Carbon," may be secured at the expense of the (chocolate brown) "Ashes," from specimens taken at a greater depth.

The locality from which the mineral comes is under the flank of a hill opposite Piccadilly Mountain, and only half a mile from the European and North American Railroad, and will not be far from a tongue of the "Coal Measures," which is represented on Dr. Robb's Geological Map as entering the valley of the Kennebeckasis from the east. The existance of true *Coal Measures* over the area in question is, however, open to doubt; while the surrounding country resembles in its contour that part of the valley which is covered by the *Lower Carboniferous formation*. Between the layers of the coal from Dunsinane, one meets occasionally with fish scales of the *ganoidal* type, and these, it is well known, are very abundant in the Lower Carboniferous, both of this and the neighbouring Province. The question could probably be determined by an examination of the plants which accompany this coal, and more surely by a properly conducted examination of the place. Our present knowledge of the district would, however, lead us to suppose that it is underlaid by the formation last mentioned, and although this group of strata is usually barren of *workable* coal seams, it is not always so, for in Scotland and on the continent of Europe, large quantities of coal are taken from it every year. A thorough search may reveal deposits of the mineral sufficiently large to be of economic importance, for the character of the sediments in the Kennebeckasis valley is not by any means such as to forbid their occurrence. Owing to the settled character of the country, and the excellent facilities for transportation, such coal seams would be a great benefit, both to the districts around and to the manufacturing interest in and about the City.

Saint John, 3rd May, 1864. G. F. M.

* Acadian Geology.

ADDENDA.

Page 14. In placing the Saint John Group as equivalent to the Potsdam or Primordial nd Quebec Groups, the Primordial *Period* (of Dana) is to be understood, including the lciferous Epoch and possibly a part of the Chazy. That portion of the Saint John roup yielding fossils, is, according to Mr. Hartt, truly Primordial, but in other portions the group, Calciferous and Chazy beds *may* be represented, establishing the comparison ith the Quebec Group of Canada.

Page 27, (5 lines from the bottom.) The Sand Point beds, before supposed to be conuous with those of Long Island, have been ascertained to be distinct, appertaining to e Portland Group.

Page 88. The name "Subcarboniferous Series" in this Report has been used as equilent to "Lower Carboniferous" or "Lower Coal Formation" of Dawson. The former m is that employed in the "Manual" of Prof. Dana, but I share in the objection which s been urged against the use of the word Subcarboniferous, as implying something of certain age, lower than the Carboniferous. Widely different as are the two series in w Brunswick, they are still so intimately connected, especially in Albert and Westmord Counties, that it is very difficult if not impossible to separate them.

Page 105. *Albert Coal.*—In confirmation of the view here advocated, that the substance ed *Albertite* is derived from *bitumen*, and is of Lower Carboniferous age, I am happy e able to add the testimony of Principal Dawson, who in a letter to myself, after a peal of the preceding Report, states, that, from his later visits to the locality, he has be e convinced of the fact that the deposit is a *vein*. The same distinguished authority, ever, inclines to the belief that the bitumen may have been derived from *vegetable* er than animal matter, and that the former may have existed as a *mucky* mud, carried streams from swampy districts, and settling in quiet waters. In such *vegetable mud*, bserves, which may be seen at the outlet of swamps, the vegetable matter is always ly comminuted.

Page 126. In the note at the foot of this page it is not intended to convey the idea, t the views set forth as to the succession of events in Cenozoic Time are *entertained* by Mr. Matthew, but merely that he is here relating his own results, and not those ur party collectively. Other eminent naturalists maintain the same opinions as those e advocated.

CORRIGENDA.

Page 12, line 9, for *is* read *are.*
Pages 17, 19 and 89, for *Sandy Point* read *Sand Point.*
Page 20, for *Queen's Lake* read *Quinn's Lake.*
Page 23, line 9, for *nominally* read *normally.*
Page 23, line 22, for *traps, forming* read *traps and tufa, forming.*
Page 25, (middle) omit the words "*if not wholly.*"
Page 101, (17 lines from bottom,) for *were originally referred* read *was originally referred.*
Page 123, line 9, for "*period of the New Red Sandstone is alone represented in New nswick,*" read *the period of the New Red Sandstone is alone known to be represented New Brunswick, although it is possible that Jurassic strata may also exist among the dstones now to be described.*